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Edited by L. B. Mackenzie

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TORCHWELD

Two things are needed to make your new opportunities yield you rich rewards—

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2. Intensive Application

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Published Monthly by the Welding Engineer Publishing Co. Entered as Second Class Matter Jan. 20, 1916, at the Post Office at Chicago, Ill., Under the Act of March 3, 1879.

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IN hundreds of plants engaged in many different industries the oxwelding torch has solved seemingly hopeless production problems by performing operations quicker, better and at less cost than formerly seemed possible.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Commercial Acetylene Welding Co.
Universal Oxygen Co.
Prest-O-Lite Co.

ACETYLENE (Dissolved)
Air Reduction Sales Co.
Linde Air Products Co.

ACETYLENE CYLINDERS

ACETYLENE GENERATORS
Air Reduction Sales Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

ALUMINUM FILLER RODS
Air Reduction Sales Co.
Bermo Supply Co.
Burdett Oxygen Co.
Wm. Cramp & Sons
Electric Arc Cutting & Welding Co.
Kentucky Oxygen-Hydrogen Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Imperial Brass Co.
Oxweld Acetylene Co.
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Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Air Reduction Sales Co.
Alloy Welding Products Co.
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Burdett Oxygen Co.
Kentucky Oxygen-Hydrogen Co.
Cortland Welding Compound Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
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Morey Flux & Chemical Co.
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United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Burdett Oxygen Co.

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General Electric Co.
Universal Oxygen Co.

APRONS (Asbestos)
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F. D. Farnum & Co.
Electric Arc Cutting & Welding Co.

ASBESTOS GLOVES
Air Reduction Sales Co.
Burdett Oxygen Co.
Chicago Eye Shield Co.
F. D. Farnum & Co.
Imperial Brass Co.
Universal Oxygen Co.
Weldit Acetylene Co.

ASBESTOS SHEET PAPER
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Burdett Oxygen Co.
Davis-Bournonville Co.
F. D. Farnum & Co.
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Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

BLOW TORCHES (Acetylene)
See "Torches"

BOOKS (Relating to Welding)
The Welding Engineer
Electric Arc Cutting & Welding Co.

BRASS AND BRONZE FLUX
Air Reduction Sales Co.
Burdett Oxygen Co.
Cortland Welding Compound Co.
Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.

Rochester Welding Works

We not only do welding, but supervise the design and installation of oxy-acetylene welding plants; report on welding material and methods; make tests on welding apparatus for efficiency and economy.

Nine years' experience.

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Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
Standard Mfg. Co.
Torchweld Equipment Co.
Universal Oxygen Co.
Weldit Acetylene Co.

BRASS SPELTER WIRE
Air Reduction Sales Co.
Burdett Oxygen Co.
Universal Oxygen Co.
Torchweld Equipment Co.
Weldit Acetylene Co.

BRAZING COMPOUND
Standard Mfg. Co.

BRAZING OUTFITS
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Aeroil Burner Co.
Hauck Mfg. Co.
Imperial Brass Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.

BRONZE FILLER RODS
Air Reduction Sales Co.
Wm. Cramp & Sons
Electric Arc Cutting & Welding Co.
Burdett Oxygen Co.
Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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General Electric Co.

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Shawinigan Products Corp.
Union Carbide Sales Co.

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National Carbon Co.
U. S. Welding Co.
Electric Arc Cutting & Welding Co.
Weldit Acetylene Co.

CARBON REMOVING TORCHES
See "Torches"

CAST IRON FILLER RODS AND FLUX
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Bermo Supply Co.
Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
Cortland Welding Compound Co.
Wm. Cramp & Sons
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
Standard Mfg. Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

COPPER FLUX
Air Reduction Sales Co.

CUTTING RODS (Elec. Arc)
Electric Arc Cutting & Welding Co.

CYLINDERS
Wm. Wharton, Jr., & Co.

ELECTRIC ARC WELDING OUTFITS
Electric Arc Welding & Cutting Co.
General Electric Co.
Gibb Instrument Co.
Lincoln Elec. Co.
Quasi Arc Weldtrode Co.
Westinghouse Elec. & Mfg. Co.

ELECTRODE HOLDERS
General Electric Co.

ELECTROLYTIC CELLS
Burdett Oxygen Co.
International Oxygen Co.
The Electrolabs Co.
Universal Oxygen Co.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
Burdett Oxygen Co.
The Electrolabs Co.
International Oxygen Co.
Universal Oxygen Co.

FILLER RODS (Aluminum)
Air Reduction Sales Co.
Bierman-Everett Fdy. Co.

THE WAR DEPARTMENT OF
THE UNITED STATES OF AMERICA
RECOGNIZES IN THIS AWARD FOR DISTINGUISHED SERVICE
THE LOYALTY ENERGY AND EFFICIENCY IN THE PERFORMANCE
OF THE WAR WORK BY WHICH
Davis-Bournonville Co.
AIDED MATERIALLY IN OBTAINING VICTORY FOR THE ARMS
OF THE UNITED STATES OF AMERICA IN THE WAR WITH
THE IMPERIAL GERMAN GOVERNMENT AND THE IMPERIAL
AND ROYAL AUSTRO-HUNGARIAN GOVERNMENT

Citation by U. S. War Department, January 31, 1920.

Commended by the U. S. War Department

The U. S. War Department bought more Davis-Bournonville oxy-acetylene and oxy-hydrogen welding and cutting apparatus than of all other makes combined.

This was doubtless due to two reasons: the reputation for efficiency established by long previous use of the company's product, and to official investigation of the company's facilities for production and service.

The Davis-Bournonville Company was and is the only concern in the industry supplying complete systems manufactured in its own factories, combining the production of acetylene, oxygen and hydrogen, portable and stationary welding and cutting outfits, and automatic and semi-automatic welding and cutting machines—the widest range of equipment manufactured for oxy-acetylene and oxy-hydrogen welding and cutting.

The requirements of the U. S. Government did not prevent the company from meeting greater demands than ever before from the commercial industries of the United States for its welding and cutting apparatus for use in "war work" in shipyards, munitions plants, and all metal-working industries. The value of the oxy-acetylene process in cutting and welding was so emphasized during the war period, that the demand for Davis-Bournonville equipment has progressively increased, and the output for the first half of 1920 to commercial industries is greater than in any previous year—a demand that is being met promptly through its great organization embracing branches in twenty principal cities of the United States and Canada.

DAVIS-BOURNONVILLE COMPANY

Factories at Jersey City, N. J., and Toronto, Canada

General Offices, Jersey City, N. J.

Burdett Oxygen Co.
Hauck Mfg. Co.
Electric Arc Cutting & Welding Co.
Imperial Brass Co.
International Oxygen Co.
Kentucky Oxygen-Hydrogen Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FILLER RODS (Swedish Iron)
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Bierman-Everett Fdy. Co.
Burdett Oxygen Co.
Bermo Supply Co.
Wm. Cramp & Sons
Kentucky Oxygen-Hydrogen Co.
Electric Arc Cutting & Welding Co.
Davis-Bournonville Co.
Federal Tool & Alloy Steel Corp.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FILLER RODS (Tobin Bronze)
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Burdett Oxygen Co.
Bermo Supply Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FILLER RODS (Vanadium Steel)
Air Reduction Sales Co.
Bermo Supply Co.
Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
Universal Oxygen Co.
Wm. Cramp & Sons
Davis-Bournonville Co.
Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FIREPROOF PLASTIC
Bermo Supply Co.
National Carbon Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
Cortland Welding Compound Co.
Anti-Borax Compound Co.
Imperial Brass Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FURNACES (Annealing)
Aeroil Burner Co.
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Universal Oxygen Co.

PREHEATING FURNACES
Aeroil Burner Co.
Buffalo Dental Mfg. Co.
Giest Mfg. Co.
Hauck Mfg. Co.
Imperial Brass Co.
Superior Oxy-Acetylene Machine Co.

GAS BURNERS (Preheating)
Air Reduction Sales Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

GAS FLOW INDICATORS
Hanau Engineering Co.

GAUGES
U. S. Gauge Co.

GENERATORS (Oxygen or Hydrogen)
Burdett Oxygen Co.
The Electrolabs Co.
International Oxygen Co.
Universal Oxygen Co.

GLOVES (Welders Asbestos)
Burdett Oxygen Co.
Davis-Bournonville Co.
Electric Arc Cutting & Welding Co.
International Oxygen Co.
Imperial Brass Co.
Torchweld Equipment Co.
F. D. Farnum & Co.
Weldit Acetylene Co.

GOGGLES
Chicago Eye Shield Co.
The Alexander Milburn Co.
Imperial Brass Co.

GRINDING MACHINES

HARDENING FURNACES
Aeroil Burner Co.
Buffalo Dental Mfg. Co.
General Electric Co.
Hauck Mfg. Co.

HOSE (Oxygen and Acetylene)
Air Reduction Sales Co.
Burdett Oxygen Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

HOISTING MACHINERY
General Electric Co.

HOSE UNIONS
Aeroil Burner Co.
Air Reduction Sales Co.
Bermo Supply Co.
K-G Welding & Cutting Co.
Hauck Mfg. Co.
International Oxygen Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
Universal Oxygen Co.

HYDROGEN GENERATING APPARATUS
Burdett Oxygen Co.
Electrolytic Oxy-Hydrogen Laboratories, Inc.
International Oxygen Co.
Universal Oxygen Co.

HYDROGEN PLANTS
Burdett Oxygen Co.
Electrolytic Oxy-Hydrogen Laboratories, Inc.
International Oxygen Co.
Universal Oxygen Co.

KEROSENE PREHEATING TORCHES
Air Reduction Sales Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Imperial Brass Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.

NEEDLE VALVES
Air Reduction Sales Co.
Burdett Oxygen Co.
The Bastian-Blessing Co.
Universal Oxygen Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Federal Brass Works.
General Welding & Eqpt. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.

NICKEL FLUX
American Flux Co.

NITROGEN
Air Reduction Sales Co.
Linde Air Products Co.

OIL BURNERS (Preheating)
Aeroil Burner Co.
Air Reduction Sales Co.
Gas Products Assn.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.

OXYGEN (Compressed in Cylinders)
Air Reduction Sales Co.
Burdett Oxygen Co.
Gas Products Ass'n.
International Oxygen Co.
The Linde Air Products Co.
Swift & Co.
Universal Oxygen Co.

OXYGEN AND HYDROGEN GENERATING EQUIPMENT
The Electrolabs Co.
Burdett Oxygen Co.
Gas Products Assn.
International Oxygen Co.
Universal Oxygen Co.

OXYGEN CYLINDERS

PIPE WELDING
Metal & Thermit Corp.
Preheaters Giest Mfg. Co.

PREHEATING FURNACES (Artificial or Natural Gas and Oil Fuel)
Giest Mfg. Co.

PRESSURE GAUGES
Aeroil Burner Co.
Air Reduction Sales Co.
Bastian & Blessing Co.
Bermo Supply Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Federal Brass Works.
Hauck Mfg. Co.
Harris Calorific Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
U. S. Gauge Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

REGULATING VALVES (Acetylene)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Federal Brass Works.
Hauck Mfg. Co.
Harris Calorific Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Universal Regulator Co.
Weldit Acetylene Co.

REGULATING VALVES (Hydrogen)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Burdett Oxygen Co.
Bermo Supply Co.
Federal Brass Works.
Harris Calorific Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Universal Oxygen Co.
Weldit Acetylene Co.

REGULATING VALVES (Hydrogen) Cont.
Universal Regulator Co.
Harris Calorific Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Smith's Inventions, Inc.
Torchweld Equipment Co.
Universal Oxygen Co.
Weldit Acetylene Co.

REGULATING VALVES (Oxygen)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Universal Oxygen Co.
Weldit Acetylene Co.

TORCHES (Oxy-Acetylene Welding and Cutting)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Federal Brass Works.
Harris Calorific Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Victor Oxy-Acetylene Eqpt. Co.
Kentucky Oxygen-Hydrogen Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
Prest-O-Lite Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

TORCHES (Oxy-Hydrogen Welding and Cutting)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Harris Calorific Co.

Texas Headquarters for Welding and Cutting. The Best Equipped Plant in the State.

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WE weld broken machinery and auto parts. Aluminum crank cases a specialty. Welders and brazers of all metals. Custom welding for the trade. Let us figure on your requirements. Imperial Brass Mfg. Co., Welding Dept., 508-510 S. Racine Ave., Chicago, Ill.

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Harris Calorific Co.
Davis-Bournonville Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Smith's Inventions, Inc.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Victor Oxy-Acetylene Eqpt. Co.
Weldit Acetylene Co.

SCORED CYLINDERS
L. Lawrence & Co.

SEAM WELDERS (Electric)
General Electric Co.

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Air Reduction Sales Co.
International Oxygen Co.
Superior Oxy-Acetylene Machine Co.
The Imperial Brass Mfg. Co.
Torchweld Equipment Co.
Universal Oxygen Co.
Weldit Acetylene Co.

THERMALENE-GAS
The Thermalene Co.

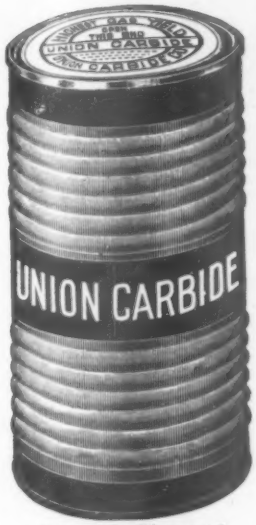
THERMIT WELDING
Metal & Thermit Corp.

TORCHES (Gasoline and Kerosene Preheating)
Aeroil Burner Co.
Air Reduction Sales Co.
Buffalo Dental Mfg. Co.
The Imperial Brass Mfg. Co.

Davis-Bournonville Co.
147 W. Austin Ave. Chicago

Davis-Bournonville Co.
Marion Jersey City

Davis-Bournonville Co.
316 Penn Ave. Pittsburgh



Packed in Blue and Gray Drums

Union Carbide Sales Company

New York City, Carbide and Carbon Building — **Chicago, Ill.,** Peoples Gas Building — **San Francisco, Cal.,** Kohl Building

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UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

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1¼ x ⅜ in. —an intermediate size.

2 x ½ in. —a medium size.

¼ x 1/12 in. —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

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Mobile—16 S. Commerce St.
Montgomery—114 N. Perry St.

ARIZONA
Phoenix—42 S. Central Ave.

ARKANSAS
Fort Smith—15 N. 4th St.

CALIFORNIA
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.

COLORADO
Denver—Nineteenth and Wazee Sts.

CONNECTICUT
Hartford—412 Trumbull St.

DISTRICT OF COLUMBIA
Washington—Maryland Ave. and 9th St., S. W.

FLORIDA
Jacksonville—515 W. Bay St.
Tampa—107 Madison St.

GEORGIA
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 75.

ILLINOIS
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—100-110 Edmund St.
Monmouth—124 E. Archer Ave.
Marion—315 S. Granite St., Box 747.
Quincy—222 S. Eighth St.
Springfield—217 S. 4th St.
Streator—501 East Hickory St.

INDIANA
Evansville—1601 Illinois St.
Fort Wayne—2216 Broadway.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.

IOWA
Davenport—118 Harrison St.
Des Moines—3rd and Elm Sts.
Dubuque—8th and Washington Sts.
Fort Dodge—10 S. 8th St.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 398.
Waterloo—1209 E. 4th St.

KANSAS
Pittsburg—109 W. Third St.
Salina—154 So. 5th St.
Wichita—535-543 West Douglas Ave.

KENTUCKY
Louisville—126 E. Main St.
Middlesboro—1701 Cumberland Ave.

LOUISIANA
New Orleans—819-21 Julia St.

MAINE
Portland—11 Exchange St.

MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.

MASSACHUSETTS
Boston—(See Cambridge "A.")
Cambridge—241 Albany St.
Springfield—Napier St.

MICHIGAN
Detroit—Grand River and Lorain Ave.
Grand Rapids—500 Shawmut Ave., N. W.
Hancock—First National Bank Bldg.
Iron Mountain—513 Stephenson Ave.
Jackson—172 South Water St.
Muskegon—303 W. Western Ave.
Saginaw—1830 No. Michigan Ave.
Sault Ste. Marie.

MINNESOTA
Minneapolis—334 N. First St.
Virginia—413 Chestnut St.

MISSISSIPPI
Vicksburg—1312 Washington St.

MISSOURI
Kansas City—1442 St. Louis Ave.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)

NEBRASKA
Omaha—1007-9-11 Jones St., Union Sta. P. O.

NEW JERSEY
Camden—West and Clinton Sts.
Jersey City—554-56 Henderson St.

NEW YORK
Albany—108 Third Ave.
Binghamton—21 Jarvis St.
Buffalo—1336 Genesee St.
Geneva—Exchange St. and Railroad Pl.
Hurleyville.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
New York.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Utica—135 Hotel St.
Watertown—438 Court St.
Whitehall—22 Main St.

NORTH CAROLINA
Charlotte—Post Office Box 777.
Raleigh—120 So. Salisbury St.
Wilmington—Room 16 Masonic Temple, 13 N. Front St.

NORTH DAKOTA
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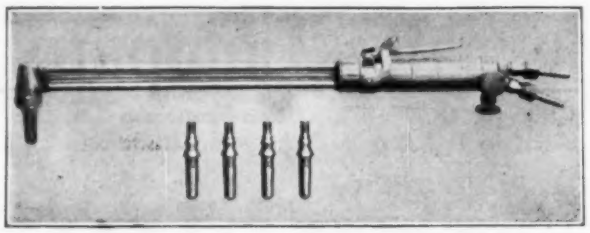

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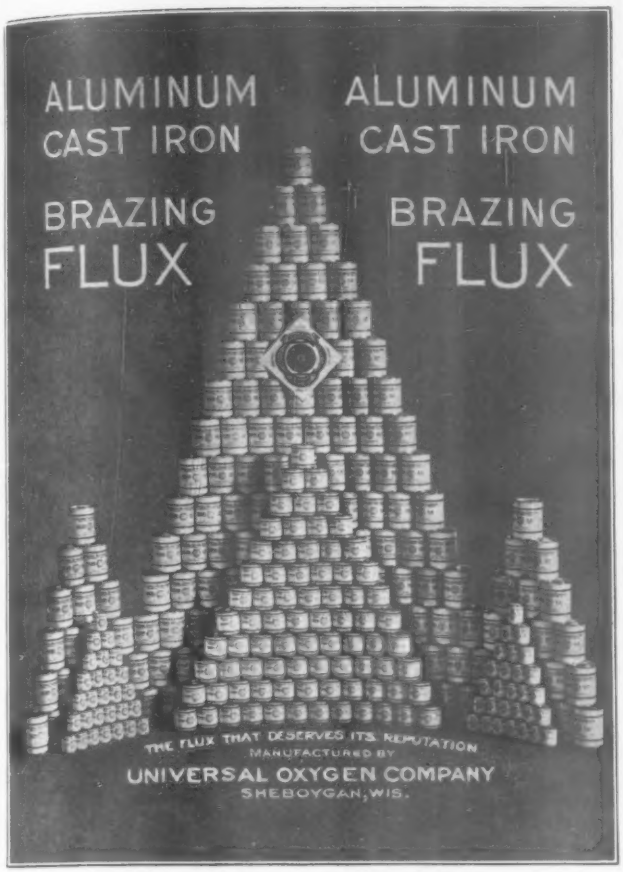

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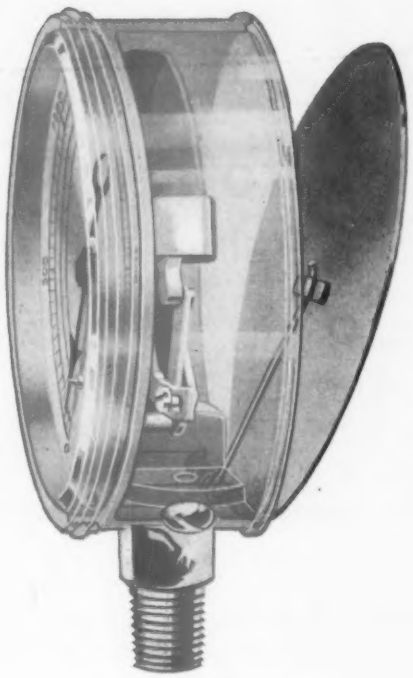

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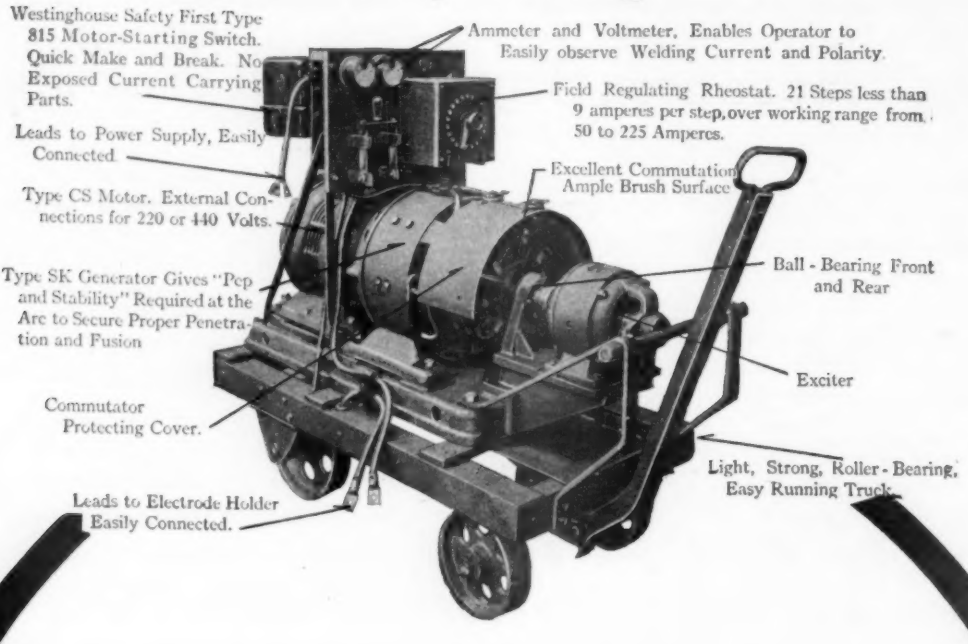
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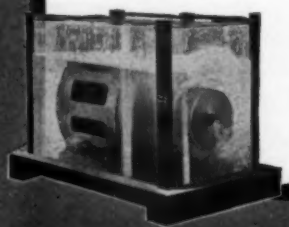

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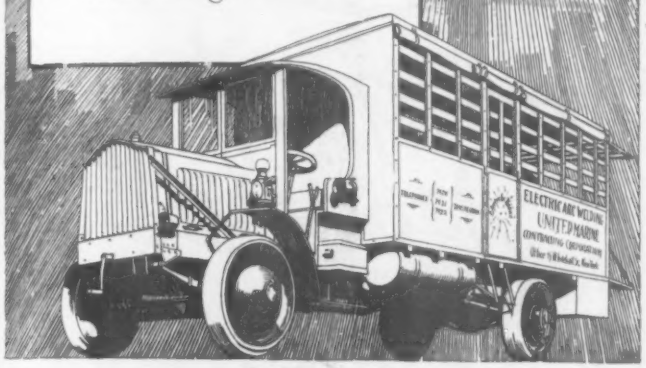

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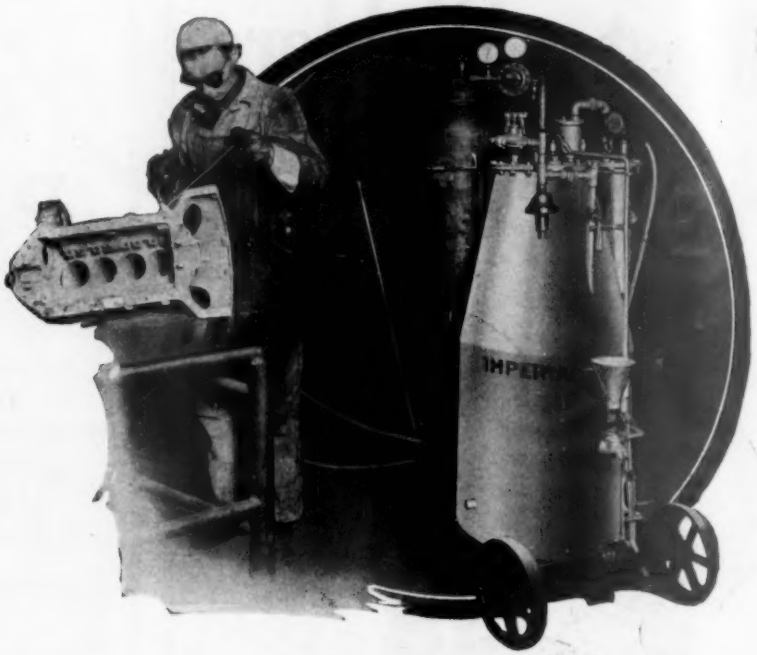

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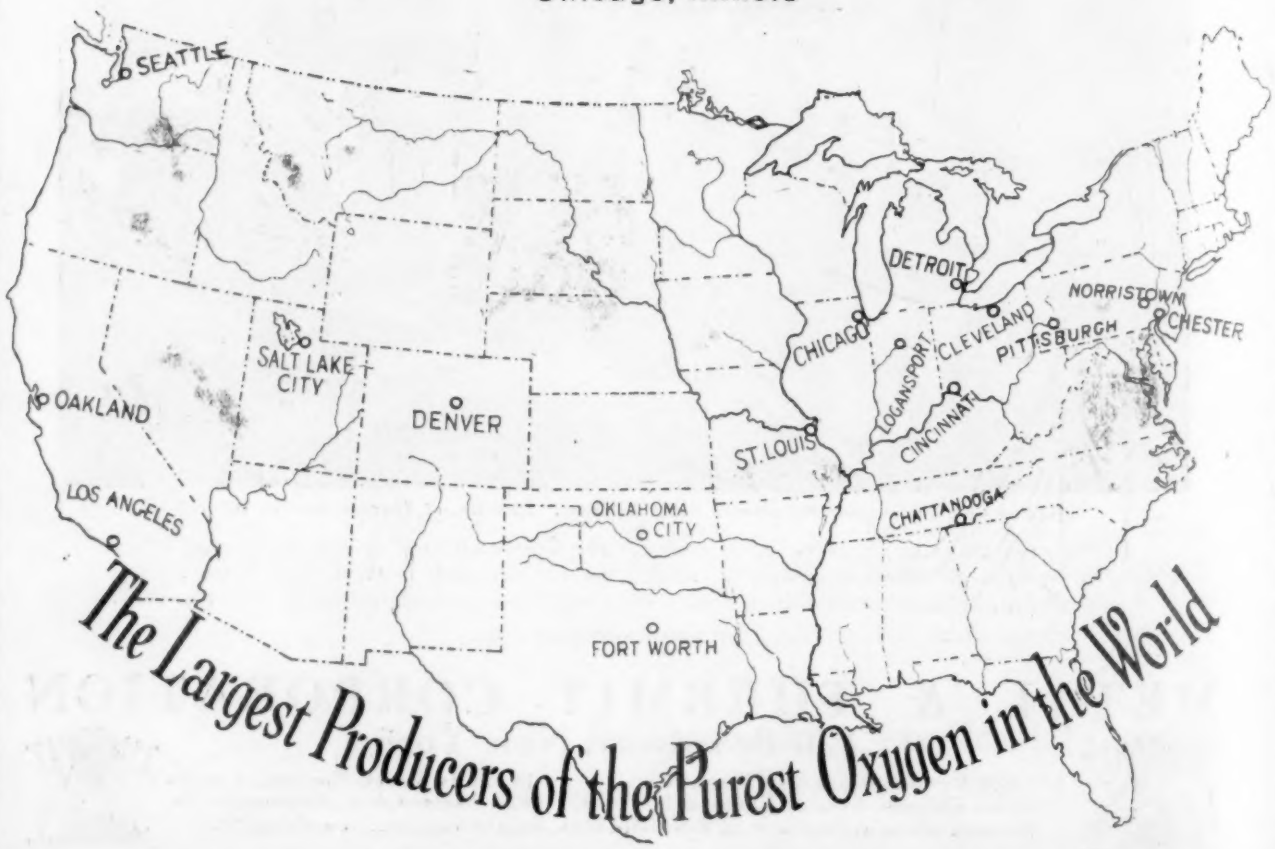

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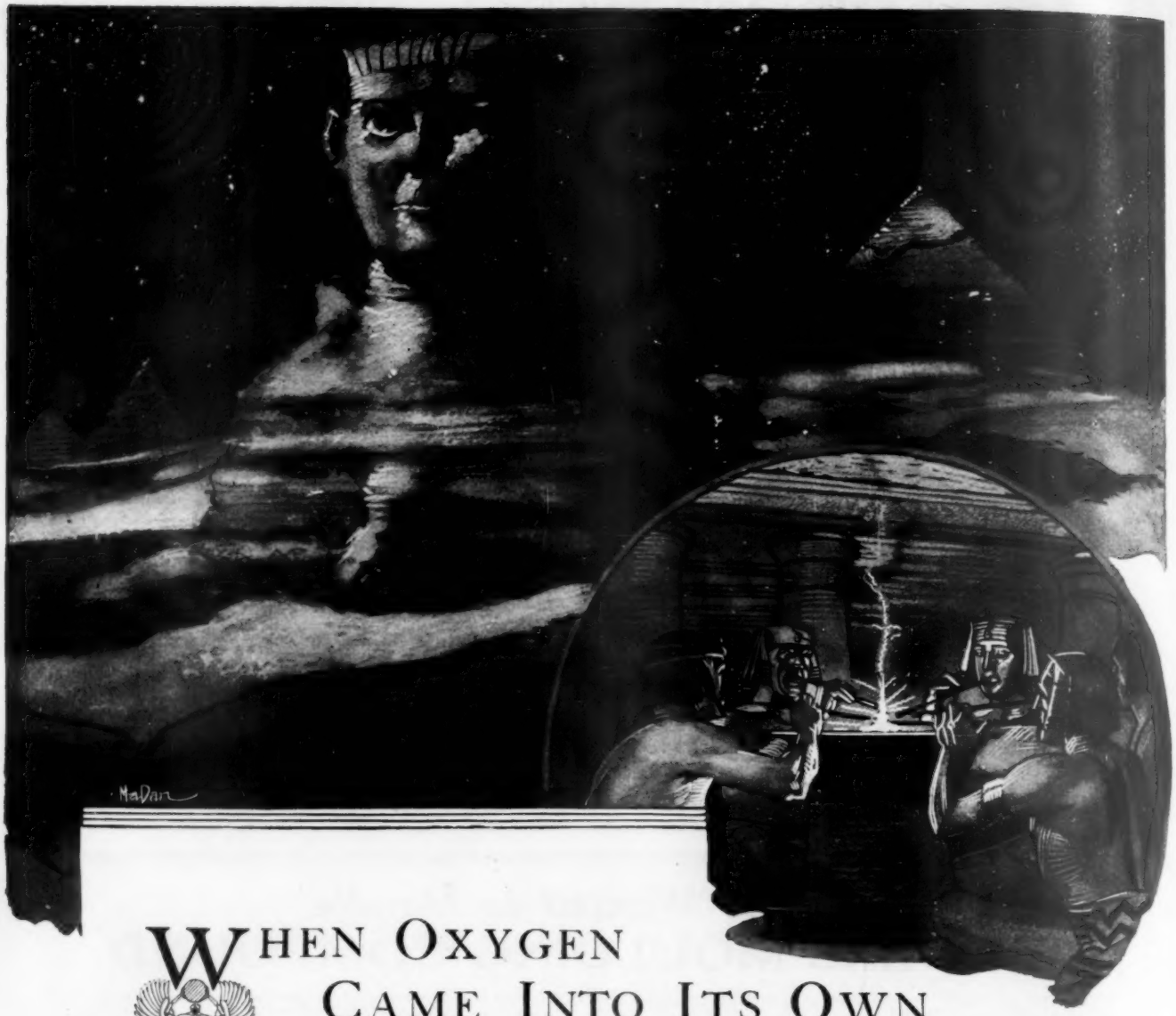

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WELDING CAST IRON WITH THE ELECTRIC ARC †

By Robert E. Kinkead *

THE salvage of broken and defective gray iron castings is one of the most important fields in which welding plays a part.

A gray iron casting may be worth from three to twenty times its scrap value, due to the labor and machining required to get it into a form which has utility for a particular purpose. If the casting is broken or slightly imperfect in the foundry, it has no utility whatever for the purpose for which it was intended. Assuming that the casting is broken in service, the parts have only a scrap value. The labor and other charges which were incurred in getting the metal into the form required, are entirely lost. When it is considered that hundreds of tons of material of this nature are scrapped every year, the enormous economic waste from this source may be realized.

Another phase of this subject and one in which the economic loss cannot be estimated arises from the economic loss due to the failure of castings, which, in turn, causes loss of production. There is no doubt but that economic loss from this source approaches the economic loss due to the loss of labor and expense in the manufacture of the casting itself when it fails.

Early Welding of Cast Iron

The earliest method of welding cast iron was developed in the foundry. In this case, the process is called "burning a casting." The casting is imbedded in foundry sand and sufficient hot metal run over the fractured part to bring it up to a sufficient temperature to make the metal plastic. At this point, the pouring of metal is stopped and the metal at the point to be welded is allowed to cool into a homogeneous mass with the metal of the original casting. This method of "burning" defective or broken castings is entirely successful but is somewhat expensive.

Thermit and Gas Welding

The introduction of the thermit and oxy-acetylene welding processes brought about successful means of repairing practically any defect or break ever encountered in gray iron castings. The work of these two processes is nothing short of marvelous. It is only necessary to visit a few of the commercial welding shops in the country to see the wide variety of castings that are welded and put back into service, for all practical purposes, as good as new.

The use of the thermit and oxy-acetylene welding processes is somewhat expensive. What is saved by their use is in most cases the loss of production or use of the casting due to the fact that a replacement part is not immediately available. In many cases, the cost of applying either of these processes is equal to or greater than the cost of a new casting.

Gradual Development of Arc Welding

In applying the electric arc welding process to the welding of cast iron, we are attempting to lower the cost of the welding so that in addition to the saving which can be accomplished using the thermit and oxy-acetylene processes, we can save a large percentage of the cost of the labor involved in manufacturing the casting. The development of the application of the electric arc welding process to the welding of cast iron has gone forward slowly for a number of very apparent causes. The most important cause for the delay in the application of the electric welding process to cast iron is probably due to the difficulty of its application. Another important feature is that the cost of electric arc welding equipment is comparatively high, so that the number of operators who have had an opportunity to work on the problem is somewhat limited. In spite of the difficulties, some progress has been made. It seems certain that the electric arc process will be used quite extensively in the future in this class of work for the reason that whenever it becomes possible to do a job at a lower cost than it has been done heretofore, that new process becomes an economic necessity.

Welding Gray Iron Castings Cold

Some important work has been done with the metal electrode process in the welding of gray iron castings cold. Among certain welding interests the tendency is to overestimate the importance of this application and to underestimate the dangers which would be encountered if this practice should ever become general. The work done in this manner is accomplishd by merely fusing a steel electrode to the cast iron. Steel studs are inserted in the edges of the cast iron pieces to be welded, and the welded material is bridged between the studs as well as being fused to the cast iron of the original pieces. The ultimate strength which may be expected from such a joint is the shearing strength of the studs minus the strength of the original pieces sacrificed by the drilling of the holes for the studs; plus whatever strength is obtained by the fused joint between the steel and the cast iron. This latter strength is sometimes estimated at a maximum of 5000 pounds per square inch. However, actual experience shows that no reliance can be placed on such a joint between steel and gray iron. The difficulty with such a joint is fundamental. If a casting is not preheated, the cast iron adjacent to the

†Paper read before theAmerican Welding Society in Philadelphia on March 11th, 1920.
*Engineering Dept., Lincoln Electric Co.

line of fusion is hard and brittle due to the fact that it was melted and cooled very suddenly. On the steel side of the weld if fusion is accomplished between steel and cast iron, owing to the high solubility of carbon in steel, a certain amount of carbon from the cast iron is absorbed by the steel added, thus giving a high carbon steel adjacent to the line of fusion on the steel side.

There are a number of applications where this kind of welding is entirely satisfactory and results in a large economic saving, but wherever the failure of a welded casting carries with it possibilities of death and destruction, such a joint should never be used. A great many attempts have been made to get around the fundamental metallurgical difficulties encountered in this kind of work, but so far, no one has been able to put anything in the welding wire or on the electrode or on the cast iron that materially changes the fundamental limitations of the process in this application.

The Carbon Electrode Process

Welding gray iron castings with the carbon electrode electric arc welding process using a cast iron melt bar has been shown to be entirely practicable on a wide range of application. The only difference between this method of welding and by the oxy-acetylene process is that the source of heat for welding is an electric arc instead of an oxy-acetylene flame. It is quite true that the difficulty in manipulating an electric arc is somewhat greater than the difficultly in manipulating an oxy-acetylene flame. The reason the arc is difficult to manipulate is that the operator must use the full temperature of the arc or must break it entirely. There is no intermediate point between. The corresponding case in oxy-acetylene welding is that in which the operator believes he is getting the metal too hot and can merely back away from the casting with the torch thus reducing the temperature, but without breaking the continuity of the welding heat. The particular difficulty encountered in the manipulation of the arc owing to this fact arises in the case of thin sections where the tendency is for the arc to burn through and in the welding of vertical or practically vertical surfaces. The temperature of the arc is so high that the metal runs rapidly, and it is extremely difficult to weld on a vertical surface. With the oxy-acetylene flame, the temperature may be reduced so that the iron is in a plastic state and a vertical weld accomplished.

Some experiments are being carried on at the present time, using a cast iron electrode and using the metal electrode process of electric arc welding. In order to work the metal this way, it is necessary to have some kind of a covering for the cast iron electrode in order to make the cast iron run with a reasonable degree of smoothness through the arc. The possibilities of this method of welding of cast iron with the electric arc process seem to be great.

Care in Preheating and Cooling

In welding cast iron either with the carbon arc and cast iron melt bar, or with the metallic arc using cast iron electrode, it is necessary to preheat the casting in exactly the same manner as if it were being welded with the oxy-acetylene flame. Care in cooling must be exercised to the same degree as if the gas flame were used.

Work is also being done at the present time in the direction of using two carbon electrodes, and not using the gray iron casting as one electrode. The object here is to make it possible for the operator to reduce the temperature and total heat applied to the point at which the welding is to be done in much the same manner as he can do when using the gas flame. This, should it prove successful, would enable the operator to work the iron at a temperature at which it is plastic, and would overcome the most important difficulties in the way of welding cast iron with the electric arc process. So far, the apparatus used in this method of welding has been cumbersome and difficult to manipulate, but there seems to be a field for improvement of the apparatus, and there is reason to believe that the difficulties will be overcome.

Use of Nickel Electrode

Some very interesting and original work was done several years ago by Mr. L. B. Brewster, who was at that time chief chemist of the Ferro Machine & Foundry Co. at Cleveland, Ohio. He developed a method of repairing small defects in gray iron castings using a nickel electrode. The advantage of this process as compared with the use of a steel electrode is that the nickel cannot be hardened by the absorption of carbon from the cast iron. The line of demarcation in such a joint between the nickel and the cast iron is an example of adhesion rather than an example of cohesion, as is the case between steel and cast iron. There is an inappreciable degree of strength in the joint. Where a small defect is filled with nickel by this process, the nickel is peaned into the defect with a hammer, so that the small spaces are filled up with nickel, and the added material held in place mechanically rather than by a fused joint. This process is in every way similar mechanically to the process the dentist uses in filling a cavity in a tooth using a mercury silver amalgam. Since the coefficient of expansion of nickel is somewhere near the coefficient of expansion of cast iron, no difficulty is experienced from the added material coming out over the heat range encountered in most castings. The nickel is somewhat softer than cast iron, and on a wearing surface, no difficulty is ecountered from this source. However, the limitation of the process comes from the fact that if the cast iron is actually melted by the arc, and it in most cases is, a hard line is left around the margin of the defect filled in this manner. This hard line interferes with machinings to a certain extent.

In spite of the difficulties mentioned, a number of concerns are using this process in the correction of small defects in automobile cylinder engines. In this case, by skillful manipulation, the nickel is anchored in the bottom of the defect, and the arc is not allowed to strike anywhere near the machined surface of the cylinder. The nickel is peaned securely into the defect and the excess filed or scraped away.

Brazing Wire for Metal Electrodes

Some work has been done using brazing wire for metal electrode in the electric arc process. A brazing job accomplished in this manner is not very reliable for the reason that in fusing the brazing rod, the zinc is vaporized sooner than the other elements of the metal, and this causes violent bubbling and porosity of the added brass.

The status of the application of electric arc welding to the welding of gray iron castings at the present time may be summarized as follows: With reference to the oxy-acetylene and thermit processes which are recognized as successful processes at the present time.

The carbon electrode method of welding with the electric arc can be used on sections thicker than a quarter of an inch where the weld may be made in the horizontal position, as well as either of the other two processes and at a considerally lower cost. In this case, the electric arc is used as a source of welding heat and the practice followed is, from the metallurgical point of view, the same as in the case of the oxy-acetylene flame. There is no greater danger of hardness of the weld when properly treated in the case of the electric arc than in the case of the oxy-acetylene flame. On certain specific applications, the steel electrode and metal electrode process is entirely practicable and much cheaper than any process so far used, but great care must be used in its application to avoid disastrous failures.

GAS WELDING *of* CAST IRON†

By C. K. Bryce*

THE introduction of oxy-acetylene welding first brought out the possibilities of cast iron as a weldable metal. The previously established methods, namely, compression or forge welding, were not applicable because of the nature of cast iron, both when cold and at temperatures commonly employed for welding. It was immediately seen that a welding process which followed so closely the metallurgy of its formation gave every indication of practicability.

The first attempts at welding were very crude. The welds were hard and brittle possessing little strength. They served to demonstrate the fusing power of the flame rather than the true welding of the material. Even these efforts created considerable interest in the foundry field, but like all innovations in an old established industry, skepticism existed. Gradually the economic possibilities of welding overweighed trade conservatism and the progressive foundries ventured into it. Intelligent coöperation and research between the foundry and the welding industry has produced a welding procedure that gives results of the greatest metallurgical soundness and is restricted in application only by the confidence of the welder in his ability and such mechanical limitations as facilities for proper handling of the work.

There are many grades of cast iron placed before the welder. They range from the crudest, just a step removed from pig iron, to the finest grained grey and white iron. All are weldable and the procedure is essentially the same.

A casting is formed from molten metal. An oxy-acetylene weld is made by bringing the metal of the joint to the same molten state and by its subsequent solidification produce a bond homogeneous with the original metal. Consequently, it is desirable that the weld metal be not only of the same chemical composition, but that it approximate very closely the same physical structure. The oxy-acetylene weld satisfies fully these conditions.

Grey iron castings are by far the most common type met by the welder. Occasionally white iron is encountered, but not enough to be of importance in welding considerations.

Grey iron differs decidedly from white iron in its physical properties,—it is soft, tough, and easily machined. White iron is hard, brittle, and machined with difficulty. The difference in the two irons is due to the status of the carbon present. Carbon is present in cast iron in two forms, in solution, commonly called combined, and free as graphite. Grey iron has more of its carbon present as graphite. This gives it an open grained greyish fracture from which it gets its name. For practical purposes it can be considered as being composed of an impure steel matrix with minute particles of carbon imbedded in it. White iron holds most of its carbon in solution. Very little of it remains in the free state. Its fracture is silvery white and close grained. It is essential that the conditions governing the formation of grey iron can be duplicated in welding.

The status of the carbon in the metal is dependent principally on the thermal treatment it receives. The relative percentage in which graphitic and combined carbon exist is influenced by the time rate of cooling. If the cooling or annealing is a slow reaction a great part of the carbon separates as graphite. If the cooling is rapid, less of the graphite separates and a higher proportion of the carbon remains in the combined state.

Silicon, sulphur, phosporous and manganese are always present in cast iron. They each have certain characteristic effects on the properties of the iron, dependent on the amount present. They, also directly, or indirectly, have an influence on the nature of the carbon present. Silicon tends to promote the formation of graphitic carbon while sulphur and manganese tend to keep it in combination. The function of these elements as well as the effect of the cooling rate are fundamental factors in the welding process.

In preparing a casting for welding the edges or cracks to be welded are chipped out to an angle sufficient to allow thorough penetration of the blowpipe flame. In some cases this included angle is 90 degrees—in heavier castings it might not be over 60 degrees. As a general rule it has been found that too wide an angle is better than too narrow. The metal adjacent to the beveled edges is also chipped or scraped to prevent any dirt or scale being blown into the weld. The casting is then ready for preheating.

Preheating is employed,—first, because it effects a saving in oxygen and acetylene in large castings; secondly, and of greater importance, it is a means of compensating for the expansion and contraction produced by the heat of welding.

The expanding forces are not usually of great concern to the welder. Contracting strains, however, offer him greater difficulty. As the weld is brought to fusion and the molten metal is added, the casting is free to expand in the direction of the weld since the fused metal offers no resistance. After the heat has been withdrawn and the metal begins to solidify, shrinkage occurs. This shrinkage must be accommodated, otherwise it will either seriously decrease the efficiency of the joint, or it will cause it to fail outright. It is not possible to anticipate the shrinkage of cast iron by spreading the edges of the joint as is done in plate metal. The casting is too brittle and the shapes and sections are too irregular. Instead, the entire casting, or those parts affected by the weld are previously heated. This produces a general expansion that is sufficient to compensate the localized contraction of the weld. In the subsequent cooling any strains that might exist are absorbed.

The extent of preheating depends on the nature of the casting and the location of the weld. The temperatures involved range from a blue heat to a dull red. The commonest form of preheating is by a charcoal fire. This is very easily applied and has met with general success. It produces an even constant heat and does not require expensive equipment to apply it. Gas and oil burners have been used but their success has been limited.

After the casting has been preheated the blowpipe is applied and the actual welding started. Grey iron melts at about 2200 degrees Fahrenheit. When the melting point is approached its transition from the solid to the fused state is very rapid. In its fused state the metal is of extreme fluidity. It is the property that permits the welding to be carried on in continuous pools, each overlapping the preceding. It is not necessary to flow or force the metal by the blowpipe, consequently, the regular oscillating motion of the flame employed in steel welding is not so essential.

This fluidity, however, offers certain disadvantages. It facilitates the flowing ahead of the metal into the cooler edges of the joint, where it solidifies as an adhesion rather than a true weld. It is also very difficult to handle except when the welding is in the horizontal plane. Vertical welding can be accomplished but it is often necessary to retard the flow by molds built up of carbon blocks or shaped from fire clay. Overhead welding is seldom attempted.

Cast iron in fusion is covered with a film of oxide. This

†Paper read before the American Welding Society at Philadelphia on March 11th, 1920.

*Engineering Dept., Oxweld Acetylene Co.

results from contact with the air. The oxide melts at a higher temperature than the molten metal. In order to bring it to fusion as is done in steel it is necessary to apply a higher temperature than is good for the metal. If it is not removed the molten metal will be enclosed in a film of non-metallic material and any additional metal that may be fused will adhere to this film rather than break through it. It prevents homogeneous fusion and is often the cause of the nodular cindery fracture found in defective welds.

It is not desirable to break down this film of oxide mechanically, for it can not be entirely removed in this manner. Large portions of it will be mixed with metal and subsequently produce a weakened structure. A fluxing material is used that will dissolve the oxide and float it to the surface of the weld. A flux is not used solely to counteract the presence of oxide. It serves as a cleanser for such impurities as sand, scale, dirt, etc. It also acts as a protecting coating to the molten metal and assists in the prevention of gas occlusions as well as the vaporization of the more volatile elements.

Cast iron is not so susceptible as other metals to the oxidizing and reducing phases of the blowpipe flame. For this reason the failure to maintain a strictly neutral flame is not always fatal. It is, however, quite sensitive to overheating. In fact the fusion produced in welding is sufficient to vaporize certain constituents. The most volatile of these is silicon. It is also the most important for it aids to keeping the carbon in the graphite state thus aiding the formation of grey iron. The loss of silicon in the weld is overcome by the use of a welding rod having a sufficient excess of this element to equalize that volatilized. A properly formulated welding rod is one of the most important factors in the execution of a weld and should always be used.

The blowpipe procedure follows the general methods employed in all fusion welding. There are, of course, slight modifications because of the nature of the metal. The actual welding of the cast iron is a comparatively rapid operation. It is possible to add a great deal of metal in a short time. In large operations where several blowpipes are employed the pool of molten metal may be of such size that pieces of the welding rod can be thrown into it, thereby greatly increasing the speed of welding. Where this is done the welder is very careful to see that the pieces are thoroughly melted before proceeding.

The fluidity of the molten metal requires that the angle of the flame be almost vertical. If an inclined flame is used it will tend to force or blow the metal ahead of the welding zone. This results in a continual source of trouble. The welding rod is also held somewhat vertically and the flame played around it, but not in contact with it.

The tip of the welding flame does not come in actual contact with either the metal or the rod, because the heat of it will effect the volatile constituents of the metal as mentioned previously. It is applied from ⅛-inch to ⅜-inch above the surface.

Flux is added during the operation by dipping the hot rod into it and then melting it into the weld. An important feature is that of continually agitating the welding by rubbing the rod through the molten metal and on the sides of the weld. This tends to work out scale, dirt, sand, etc., to the surface. It also breaks up gas pockets and assists considerably in producing a thorough fusion.

After the weld is finished, it is smoothed over by the flame. It will be covered with a film of flux, scale, dirt, etc. This is very hard, almost glassy, and is practically impossible to machine through it. It is removed while the weld is still hot, by scraping. If it is allowed to cool, it can only be removed by grinding. A great number of welds have been condemned for hardness merely because this film was not removed.

After the weld is smoothed off the casting is annealed. When soft tough welds are required, all castings are given this treatment. In some it is more or less superficial; in others it comprises the most important stage of the operation.

Annealing produces two effects that are essential to good cast iron welding. As previously mentioned, it promotes the formation of grey iron by giving the proper time rate of cooling. If it is not employed white iron will result. It permits the distribution and elimination of internal strains, either previously existing in the casting or introduced by the contraction of the cooling metal.

In small castings which have been given only a slight preheating treatment, annealing is carried out by first playing the blowpipe on the weld and surrounding metal till it is a good red heat and then covering it with asbestos paper or any other insulating medium so that it will retain its heat and not be subjected to drafts or air currents. In large castings which have been preheated in a charcoal furnace, this same furnace is used for the annealing treatment. The casting is first covered over with hot coals of fire. The air ports of the furnace are closed and the top covered with asbestos paper. The casting is then allowed to cool with the fire. It is never removed from the annealing furnace until it is cold. Sometimes this takes from 12 to 24 hours. When the casting is cold, it is removed from the furnace, cleaned up and in some cases the surface of the weld ground smooth. It is then ready for machining or service as the case may be.

It can be seen from the foregoing that the principles involved in cast iron welding are very elementary. The actual blowpipe operation is comparatively simple. It requires little practice to master it thoroughly. The welder may possibly have a little difficulty in controlling the molten metal because of its tendency to run ahead of the weld, adhering to the cooler metal rather than fusing with it. He may also have a little trouble with the working out of impurities and breaking up of blow-holes. These troubles are possibly the commonest faults encountered as far as actual fusion is concerned.

The important factor in the handling of a casting for welding is that of properly laying out and setting up the job and the application of satisfactory preheating and annealing methods. The blowpipe difficulties can be overcome by intelligently grasping the principles involved. The remainder of the welding procedure requires a little experience and practice before it is mastered. Owing to the varied nature of castings, as to quality, shape and size no set rule of thumb can be employed. A familiarity with their actual behavior under welding conditions is necessary. There is no doubt that the oxy-acetylene welding of cast iron is a process of great importance to the machinery and metal working field. Its limitations have not yet been reached. Today the limiting features are simply that of shop facilities for handling the work and confidence of the manufacturer in the process.

In the first years of its introduction, naturally, the simplest types of jobs were encountered. The success resulting was sufficient to cause the welder to aspire to larger and more complicated work. Today such work as the welding of large engine castings, massive crushing machinery, punch presses, and other heavy duty castings are accomplished without question or comment.

The savings in idle time of machinery and replacing cost brought about by this process have amounted into the hundreds of thousands of dollars. During the recent war when all efforts were directed towards the manufacture of war machines, transportation and shipping, the emergency assistance rendered by the blowpipe was of immense value to the country. In the railroads alone, in both this and European countries, the blowpipe was practically indispensable in maintaining equipment and rolling stock.

Cast iron welding is essentially a process of reclamation and repair. Foundries use it extensively in the reclaiming of castings that are defective from blow-holes, or broken parts. All machinery users employ it in the repair of parts broken in service. The properties of the welded metal being equal, and in some cases superior to the original metal of the casting, a 100% metallic union results.

Past performances of the welding blowpipe in this field prove conclusively that its application has been sound and that its present rapid growth is due solely to the merits of the process. Future expansion of its application at the same rate is assured.

Discussion

After reading the report, W. O. Thompson (N. Y. C.) said: "Your committee has received considerable criticism for the conservative limits set on fractures allowed to be welded. For two or three years, I was of the same opinion as the critics, but my opinion was changed by seeing several very disastrous results, not of welding, but of soldering over the edges of fractures on different parts of cars that afterward failed, and caused serious accidents."

Prof. Alfred S. Kinsey (Stevens Institute of Tech.): As a director of the American Welding Society of New York City, I have asked the privilege of the floor to announce to you

How They Advertise Welding in Texas. Is YOUR Window Paying Dividends?

REPORT OF THE COMMITTEE ON AUTOGENOUS WELDING

The report of the committee to the last convention was adopted by letter ballot and incorporated in the American Railroad Association Code of Rules (M. C. B.) governing the condition of, and repairs to, freight and passenger cars in the interchange of traffic.

There were three subjects referred back to the committee for further investigation and report, viz.:

1.—Building up flat spots on steel and steel tired wheels.

2.—Building up of worn collars at the journal ends of axle.

3.—Welding of fractures in couplers.

The committee has done considerable work on these subjects during the past year, but has not to date concluded its investigation and tests. In addition to the subjects left over last year, the committee is making a thorough study of the relative merits of autogenous gas and electric welding on the various parts of car and locomotive equipment.

The report was signed by J. T. Wallis (Chairman), Pennsylvania System; W. O. Thompson, New York Central; G. W. Rink, Central of New Jersey; A. M. McGill, Lehigh Valley; R. W. Schulze, St. Louis-San Francisco; Willard Kells, Atlantic Coast Line; H. T. Bentley, Chicago & North Western; Geo. Durham, Wheeling & Lake Erie; T. P. Madden, Missouri Pacific; H. B. MacFarland, Atchison, Topeka & Santa Fee, and G. M. Gray, Bessemer & Lake Erie.

that a special committee has been appointed to take up the problem of welding as it affects organizations such as this. The committee also will co-operate with the Boiler Code Committee of the American Society of Mechanical Engineers to do everything possible to promote a mutual interest in successful autogenous welding. It has been generally supposed that the safe ending of boiler tubes was condemned by the American Society of Mechanical Engineers but neither that society nor its boiler code committee ever took any such action so far as fire tubes are concerned. There is not anything on the records to show how they stand regarding the safe ending of fire tubes for locomotives. They do not approve of the safe ending of tubes in water tube boilers. The different societies are asked to form committees to co-operate with the welding society's committee, and the committee of the A. S. M. E., to determine how far we should go in allowing welds to be made in tension members and compression members; similarly in vessels under high pressure. The conference of all these committees should also discuss the question of licensing welders. The insurance companies are becoming very sensitive about the matter, because of the lack of control of welders. Shall we license welders? You men who are very much interested in autogenous welding in the railroad shops should have a voice in the decision of that question.

Autogenous welding has come to stay. The best engineering schools in the country are teaching autogenous welding. At Stevens Institute of Technology we are teaching every

one of the 850 students passing through that school the four methods of welding including the torch weld, the thermit weld, the electric weld, and the oxy-acetylene weld. They will never be welders, but they will know what a good weld is when they come to be assistant managers of shops, and have these welds to consider and to deal with. Night schools now are being conducted for the instruction of welders. During the war, a night school was started in New York, which is still continuing its work, because there is such a demand for gas welders.

It was my privilege to see in Mr. Pack's office in Washington a few months ago, the example of poor welding he referred to in his report on boiler explosions. The trouble in those cases was that the men who made the welds either had no conscience, or no knowledge of how to make welds. They were the worst I ever saw, and it is not fair that they should be allowed to condemn the process of autogenous welding. I believe that Mr. Pack did not intend to condemn autogenous welding, but only wanted to call attention to the fact that the method, although a good one, was at the same time so important that it should be handled only by intelligent men; hence the thought of licensing welders, on my part.

At the meeting of the Master Boilermakers' Association a week ago, in Minneapolis, they voted to have a committee of five appointed, which was to be known as a conference committee, and which is to confer with these other committees. In a short time, we will probably have a meeting in Chicago or New York, and with all of these gentlemen sitting around the table and officers like Mr. Pack, represented, men who are vitally interested in the subject, it is hoped that recommendations of great value will be formulated. We would appreciate very much having the co-operation of this organization. I understand you have a committee on welding, and presume the matter can be handled through that committee.

C. E. Fuller (U. P.): Am I to understand that the American Society of Mechanical Engineers is advocating the licensing of welders?

Mr. Kinsey: No, sir. I did not mean to imply that. I meant to say that some of us, in talking this over (I am a member of the A. S. M. E., but did not speak for that organization officially) are of the opinion that something should be done and must be done before long to put the stamp of approval on good welding, and the stamp of disapproval on carless welding. We must either license the welder or his boss to bring that about. In New York City they have had a requirement for a long time that welders must be licensed. You cannot perform a welding operation in that city without submitting to an examination at City Hall and paying $5 for a license.

Mr. Fuller: I am a member of the American Society of Mechanical Engineers, and know something of their methods. The A. S. M. E. has a work to perform, and in performing that work, should we all be crucified because some of its members are representatives of insurance agencies and other interested parties? I think we had better consider this thing pretty carefully. We had our experience in the case of the boiler code. It is to be regretted that this committee did not present a report this year more in detail than it has done. We are not interested in some things, but we are interested in life and safety. There is nobody more interested in that phase of the question than the railroads. We are not doing this work haphazard, or for money. We are not being paid for the job. It makes all the difference in the world whether it is a blacksmith's shop on the outside, or whether it is one on the inside, and I for one want to protest against any action being taken here until the matter is carefully analyzed.

R. W. Bell (I. C.): We have approached the matter of welding very carefully, and we want to go on record as protesting against the manner in which truck side frames have been welded. We have had some very bad accidents because of the fact that they were simply soldered. I do not believe that you should have licensed welders. By selecting men carefully from among our various apprentices we can do all that is necessary to train efficient welders. By appointing the most intelligent men for this class of work we can get good results.

J. J. Tatum (B. & O.): Autogenous welding is a very deep subject. At the last convention we applied the emergency brakes and stopped perhaps too short. As Mr. Bell has said, there has been some very bad welding done; in fact there have been attempts to weld, and parts of cars have been passed as being welded that were not welded. According to the description which is given by some of our men they have the appearance of being whitewashed.

We can do more welding than we have decided should be done, but it must be done under the direction of some responsible official. It is not only necessary to consider the method of welding, but the part to be welded. The question many times is the character of the casting or forging that we are undertaking to weld. Is it worth welding? We may apply a good weld to a bad casting, and if we do we have gained nothing, and therefore, good supervision is necessary to get proper welding of the proper material.

F. W. Brazier (N. Y. C.): I want to bear out what Mr. Tatum and Mr. Fuller have said. You will notice that the committee asks for further time in which to make a study of the matter. We have some mighty poor welding, and it is better not to weld at all unless we can do it right; it is better to scrap the material rather than pay in accidents on the road. We have quite a bright set of men on the railroad, and by supervision and the work which this committee is going to do I feel confident we shall develop good men.

I. S. Downing (C. C. C. & St. L.:): There is just one question in my mind on this matter of welding. It is a preferred job, and under the National Agreement I suppose we will have to bulletin the job.

Prof. Kinsey: I am afraid that you have lost track of what I said first—that I came to you as a member of the American Welding Society, not of the A. S. M. E. My motive this morning was entirely an unselfish one, prompted by the desire to obtain exactly what you men want. We have asked the A. S. M. E. to hold off with any more restriction and to stop their discussion of this whole situation until the organizations can get its committee together, discuss the question and establish the limitations. If it is not best in your judgment to license welders, then we won't license welders, that is all.

E. Wanamaker (C. R. I. & P.): The American Welding Society has done some very good work along research lines. As I understand it, they are not proposing to set any particular limitations, but to try and co-ordinate the efforts of all organizations interested in autogenous welding, in order that each one may benefit from the findings of the other. So far as that goes, it might be well to have the railway orgaizations co-operate, and eventually they can make definite limitations. The autogenous welding industry is certainly in its infancy, but we do know one thing: that the complications in the reduction of costs of maintenance and operation are going to force us to use many new processes. To use them intelligently, it will require intelligent investigation and research, which no doubt will be a continuous process for some years to come. I think that we should confine our work within certain definite limitations. After it has been proved and demonstrated that we can go farther afield, then the limit should be raised and I think that is what this organization is going to do. At present we have excellent equipment available for thermit, gas and electric autogenous welding, but there are three prime requisites to be met in any or all of these three processes if the welding is to be successful. Agreeing with the chairman of the committee, that the

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failures in autogenous welded parts have been in part due to the fact that they were not welded, if we are going to get these welds done properly, we must make sure of the three prime requisites, which are: first, proper material for making welds; second, rules for using those materials; and third, intelligent application of the process in the design, to the various mechanical devices or articles that are to be welded. To secure that co-operation we need a man who is skilled in making the weld and blowing the metal into the weld.

We should all realize that in any autogenous weld the best we can do is to put good cast iron, cast steel, or alloy steel, into the casting. That being the case, certainly no effort should be spared to secure the proper materials for welding. If we are going to join high grade materials, whether it be in truck frames or boiler steel, we should first secure good materials to go into the weld. We should spare no expense or pains in an unceasing endeavor to thoroughly train our mechanics until they are capable of making first-class welds with a good high average of efficiency and factor of safety. Everybody in the mechanical department, having to do with the application of welding should get down on the ground and study the application, so that it can be intelligently applied.

A. M. Simons (P. S. & N.): One of the most prolific sources of poor welds is their extended operations before the welders and those in charge have time thoroughly to master the process themselves. Their ambition to make a showing in the way of saving parts that have formerly been scrapped has frequently led men in the wrong direction, and caused them to use welding where it should not have been employed. We should proceed with that degree of caution which will insure confidence in the man that is doing the work; ability to supervise in the man who is responsible for the work in its last analysis, and also the ability to judge as to whether the materials should be welded or not. As to the licensing of welders, it is simply a term, meaning qualification. That is a matter to be decided upon by the different people interested in welding. The A. S. M. E. will of course, treat this matter in the light as it appears to them, and you gentlemen should, I believe, do the same. But I bespeak of this body, your cordial co-operation and support, and assistance in building up a society that can do you a good in this field. In doing that, you will also give yourselves added protection against what has been mentioned here to-day as unsatisfactory welds—welds of a character that cause you to look upon the problem with a degree of caution that in some instances has been taken as a condemnation. Certainly bad welding should be condemned, and good welding should be commended and extended, so far as it can be without endangering the character of the work that is being turned out.

C. F. Giles (L. & N.): Mr. Downing spoke of the requirements of the National Agreement, with respect to seniority governing the selection of men for doing this class of work, and created some levity, but in my opinion it is a very serious problem that we are dealing with in that respect, and I feel that this Association should go on record as advocating the establishment of the welding art as a separate trade, so that men can be trained for that class of work, and thus remove the embarrassment resulting from having it done by men belonging to the various crafts. It has caused a great deal of dissatisfaction ever since the present National Agreement became effective.

R. W. Bell (I. C.): If I understand the National Agreement correctly, there is nothing in that agreement which says that welding is a preferred job. In the matter of welding, you can select your men, and we do select our men as to merit and ability from the different crafts.

H. M. Curry (N. P.): I agree fully with what Mr. Giles says. On the Northern Pacific Mr. Bell could not put across his program that he just speaks of as being effective on the Illinois Central, and I hope that Mr. Giles' suggestion will be made effective. I am in hearty accord with him. There isn't any occasion for levity about the proposition. We are confronted with a mountain of trouble in connection with it, and my thought in making any remarks at all is, whether this is the proper time and place to consider a situation that must eventually be changed.

MR. NAPOLITAN'S PAPER

Editor: I would call your attention to a number of errors in your copy of my paper that give the impression of being discrepancies and which I would appreciate your correcting.

In the second paragraph your copying remarks "but the temperature was too far removed from the Ac. 3-2-1 point to *afface* the characteristics of the pearlite." The word "afface" should have been "affect."

In the third paragraph your copying remarks "we recognize the presence of the final and most stable state of *carbon-graphite.*" You use a hyphen which makes it appear that I am referring to a peculiar and up to this time unknown form of carbon known as carbon-graphite. This mark of punctuation should have been a "dash."

In the seventh paragraph or the second paragraph from the end you remark, "As the comparatively low temperature produced by preheating was insufficient to *affect* any change in the physical state of the constituents." The word "affect" should have been "effect." F. J. NAPOLITAN.

MR. KINSEY'S PAPER

Editor: The July, 1920, issue of your monthly contains a copy of a stenographic record of my remarks at the recent Master Boilermakers' Convention held in Minneapolis, and I am disappointed to find that so worthy a publication as *The Welding Engineer* should be so indifferent regarding accuracy of such material. It was discouraging enough to have the stenographer make such unreasonable blunders, without having them presented to public view by your journal. For example, I am supposed to have said that air is composed of oxygen and hydrogen (instead of nitrogen). Most any school boy knows better than that. Again, I spoke of *termit* welding and the stenographer has it *endo thermic* welding. Also in a number of places my remarks have been so badly garbled that they make no sense. If you and the Secretary of the Master Boilermakers' Association had only waited for me to edit the stenographic record of my remarks, much embarrassment would have been avoided. I read every issue of *The Welding Engineer*, and it is only because of my interest in your paper that I call your attention to the matter outlined above.

A. S. KINSEY,
Prof. Shop Practice
Stevens Institute of Technology.

Editor's Note: No attempt is made by The Welding Engineer to verify papers published by various societies. It is assumed such papers are properly corrected before being distributed to the press.—Editor.

THE STATUS OF AUTOGENOUS WELDING

There is a growing belief that autogenous welding has its limitations. The early enthusiasm with which the process was accepted by the railroad is suffering a reaction which, no doubt, is the natural outcome of the attempt to make it a panacea for all the ills of wear or failure to which metal parts of railway equipment are heirs. There is, however, grave danger that the reaction will carry the railroads as much too far in the direction of conservatism as the early enthusiasm carried them beyond the limits of safety and

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economy considering the undeveloped state of the art when it was first brought into the railroad field.

There are three prime essentials to successful autogenous welding. The first is a properly trained and experienced operator; the second is the proper preparation and laying out of the work; the third is the use of proper welding materials and appliances. The third requirement involves no real difficulty, as proper materials and appliances are available. But in the case of the first two essentials much remains to be done before the full possibilities of the art can be realized. The danger from the standpoint of future development lies not in the establishment of temporary limitations, but in failure to recognize the true nature of the cause which makes them neccessary. Machinists, boilermakers, and even barbers, after a few days of special training, are alike frequently considered competent to operate on important work. When the results are not all that should be expected from really competent operators, there seems to be a tendency to attribute the failure of inherent limations of the process itself. The fact is overlooked that success in welding depends far more on the skill and the integrity of the operator than in the case of any of the well established trades and yet years of apprenticeship are required in these trades.

This is in no sense an argument against the establishment of such temporary limitations as are best suited to guard against danger from ill advised and incorrect applications of the process. But unless the nature of the real problem is clearly recognized the minds of many mechanical department officers will be closed to future developments and limitations, once established, will be considered as permanent.

A few railroads have attacked with energy and thoroughness the economic and technical problems involved in the establishment of intelligent limits and correct practice in the application of autogenous welding. These roads have met with success in fields where the average experience has been failure and their success is justification for the belief that future developments will undoubtedly make possible a considerable extension of the present limitations. The art is in its infancy and its possibilities for the conservation of both labor and material are so great that it would be extremely unfortunate for the railroads if a misapprehension as to the nature of its present limitations were to delay the day when they may legitimately be extended.—*Railway Mechanical Engineer.*

NEW WELDING SCHOOL

The Submarine Boat Corporation, Newark, N. J., are planning a school for the training of electric welders, which has the hearty endorsement of the American Welding Society and which is directed by men well fitted for this class of work. This school is unique in that it is not connected with any apparatus manufacturer, and its students, therefore, will receive training on various types and makes of machines. As the American Welding Society offers this news to the welding industry, it cannot emphasize too strongly the importance of highly trained welders. Feeling that the industry realizes this also, it seems fairly certain that this training school will be a success.

A letter, dated June 4, from the Submarine Boat Corporation, signed by Mr. Harry H. Tukey (Director of Training), quoted below, explains the matter more fully. The Society would be glad to have all those interested indicate this interest to the Submarine Boat Corporation, so as to assisted them in determining how to proceed.

June 4th, 1920.

Mr. J. H. Deppler, President,
American Welding Society,
29 West 39th St.,
New York, N. Y.

My Dear Mr. Deppeler:

As requested by you during my visit at the Society's rooms, accompanied by Mr. Odiorne, at which time we conferred upon the possibility of training electric welders at Newark Bay shipyard for outside agencies, permit me to offer for the consideration of your Board of Directors, the following suggested procedures. I am putting this up in terms of three propositions which we feel cover a wide field and should adequately take care of the situation. Any one of the three may be selected by persons desiring to have welders trained.

Proposition No. 1: Applicants would be trained upon a series of exercises only, no productive work entering into the training whatsoever. Men completing this unit would leave with an understanding of and ability in electric welding, but with no actual productive experience. It is estimated that such a unit might appeal to concerns who are manufacturing welding machines but are now training their own operators. It is estimated that this course would probably require one week's time and would involve an expense of $15 per man.

Proposition No. 2: Applicants would receive the preliminary training mentioned in Proposition No. 1, plus a training in either a unit which would be confined to mild steel and other metals, or in a unit in which machine parts and other castings predominate. Applicants in this group would be trained upon productive work and at the close of their experience would be qualified to immediately assume productive responsibility in the type of work in which they were trained. This unit would require approximately five to six weeks to complete, and would involve a cost of approximately $50 per man.

Proposition No. 3: Applicants entering this course would be given all that is contained in propositions No. 1 and No. 2, plus a training in carbon arc cutting and in the use of the acetylene torch for cutting purposes. Men would be trained upon productive work and when completing the course, would be qualified to assume productive responsibility either upon mild steel or upon castings. It will require approximately eight to nine weeks' time to complete this course and would involve an expenditure of $85 per man.

In all of the above propositions, men would receive training upon both alternating and direct current machines.

It, of course, must be understood that estimates given above are subject to change both as to length of time required in the course and expense, and it is my belief that any revision would be downwards rather than upwards.

It is further taken into consideration that any proposal must be sufficiently elastic to permit of either the individual entering training at his own expense or employing companies assuming the expense of training their welders.

Inasmuch as we have been conducting the training of our electric welders for the past two years, during which time we have trained seventy-four welders, we feel that our ability to train competent men for outside agencies is unquestionable.

It might be mentioned in connection with the above that it will be our object not only to develop full manipulative ability in applicants but as well to include in their training the trade technical content that should make them intelligent operators.

I trust that the above will meet with the approval of your Board of Directors and would be very glad to give such other assistance as I may in the furtherance of the proposal.

Yours very truly,

SUBMARINE BOAT CORPORATION
NEWARK BAY SHIPYARD
(Signed) HARRY H. TUKEY,
Director of Training.

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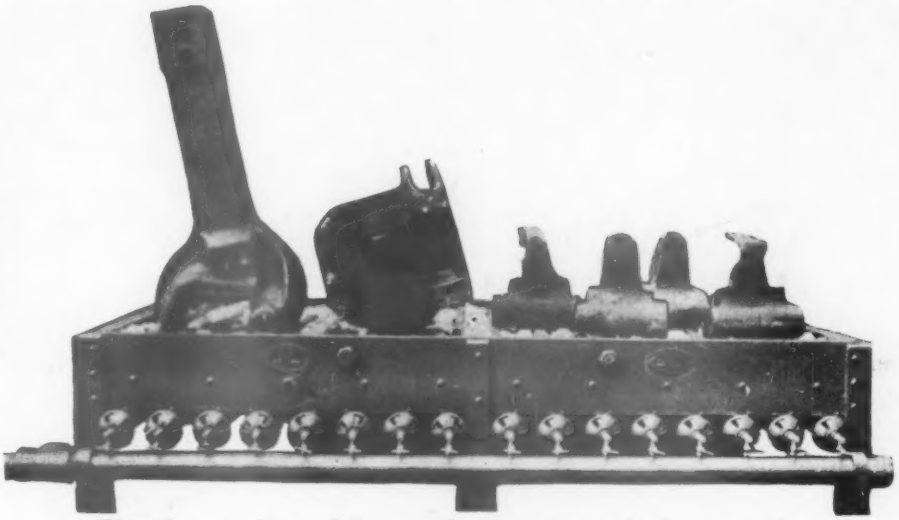

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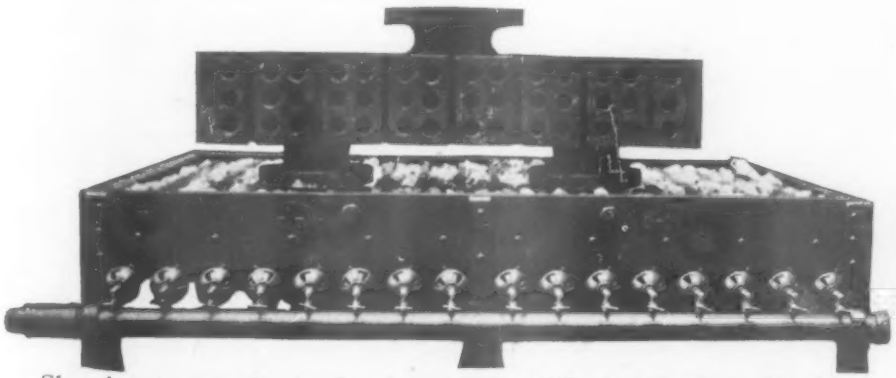

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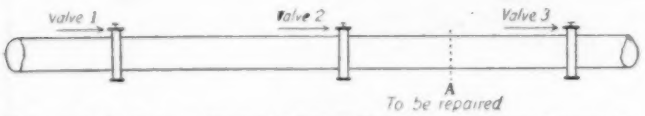
OXY-ACETLYENE WELDING OIL PIPE LINES

The rapid advance in the use of oxy-acetylene for welding pipe lines and the assured indication of still further advancement in the near future make the present an especially appropriate time to consider the adaptability of the process, the methods employed and the results obtained.

Many of the foremost oil companies in the country are building and using welded oil carrying lines, but there are yet many others that retain the old method of screwed pipe connections.

There are a great many welded pipe lines in the Wyoming field. The Midwest Refining Company has an all-welded 4 in. pipe line which extends from Salt Creek to their refinery, 56 miles distant, at Casper. At the gas plant of the Ohio Oil Company, in the Lance Creek Field, oil lines from one to twenty inches in diameter and with working pressures as high as 800 pounds are welded. All of these have proved efficient and satisfactory. Most of the welded lines of any considerable length in this territory are 3 in. pipe and are used for gasoline.

In the West Virginia fields, practically all of the lines are controlled by two concerns, pioneers in the territory, that laid their lines before the development of the oxy-acetylene process. Now that the younger companies have adopted this process, the older ones are making use of it very extensively for new construction and repairs, as experience has proved that the welded joint can be put into the line at a material saving in time compared to the screwed connection.



Valve 2 Is Left Open During Welding Operation to Allow Escape of Pressure.

The time element is of first importance in the repair of leaking or damaged lines in this region, where 6" and 8" pipe is used and pressure tests range from 800 to 900 pounds. Lines of this size and under high working pressure will lose considerable oil if leaks develop. It is often necessary to cut the main carrying lines for the connection of laterals. This cutting is done much more quickly with the cutting blowpipe than with the old method in which a pipe-cutter was used.

One Wyoming company facilitates its pipe line repairs by installing valves at intervals of from 300 to 1,000 feet, depending on the size of the pipe. Between the valves, alternating with them, are other valves or plugs for use as blow-offs to drain sections on which repairs are needed. Plugs are usually preferred to valves, as they are more economical.

In the illustration, supposing a break or leak occurs at "A", valve 1 is closed, valves 2 and 3 remaining open until most of the oil drains off. (It is not possible to drain the section entirely dry.) Valve 3 is then closed, valve 2 being left open to allow the escape of pressure due to any explosion that may result upon the application of the cutting blowpipes.

Where it is desired to repair a line not equipped with blow-off valves or plugs the first opening can be cut with a hack-saw so that any flame or gas caused by application of the blowpipe will escape without doing any harm.

Another Wyoming concern, which operates many miles of 8" line that is not equipped with valves or plugs, uses oxy-acetylene for repairs by employing a saddle-clamp to make a by-pass around the defective portion, which is then removed and a new section installed, thereby avoiding the necessity of shutting down its pumping station, which might be miles away from the work. Where this method is used it is important that the saddle-clamp and by-pass apparatus be designed by a competent engineer with special reference to the pressure problem involved, and that the work be carried on under the supervision of an experienced man who is familiar with the operation and the special conditions with which he has to deal.

Yet another method devised for the repair of an 8" line near Caney, Kansas, laid some eight years previously and which was leaking badly at a coupling, was to have a vacuum placed in the line by the Caney and Bartlesville (Okla.) pumping stations. The coupling was then removed, the open ends being filled with mud as an added safety feature. The new section was welded in and 800 pounds pressure was restored with satisfactory results.

Where lines in which "go-devils" are used for cleaning the pipe are built, the pipe has to be welded so that there will be no interior projections of metal to obstruct the device. Fortunately, by the use of pipe that has been properly beveled before welding, this requirement is well within the range of the skilled welder who employes the oxy-acetylene process. Beveled pipe is now manufactured and sold at the same price as ordinary pipe.

Many of the prominent men in the Wyoming field, after two years' experience with welded oil pipe lines, firmly attest their success. Extensive development in new lines will be made this year, and many of the new lines will be welded.

That the application of the oxy-acetylene process to this industry has passed the experimental is proved by the lines now giving excellent service. Condition and character of terrain oppose no obstacles in the welded line. The sections may be welded together either on or above the ground level over the trench and rolled or dropped to the trench bed, where it automatically conforms to the bed and sides without injury to the line in its body or joints. It has been definitely demonstrated in numerous construction projects that continuous welded lengths of hundreds and even thousands of feet of pipe may be handled in this manner without developing the slightest break or gas leak in any part.

As for the economy and strength of welded versus screwed pipe joints, it has been conclusively shown in the Fowler shops of the University of Kansas that the former cost less, the saving of welding increasing as the size of the pipe is increased. Welding takes less time, is just as strong, and can be made even stronger by "building up" the weld. The elasticity of the welded pipe is clearly indicated in its conformation to trench bed and sides previously noted. Conformation in the pipe line having screwed connections has to be accomplished by laying the pipe in the trench and fitting the connections in that position.

WELDING WORN FLANGES

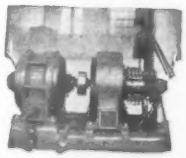
Editor: In the June issue of *The Welding Engineer*, Mr. John J. Foley seemed to be trying to throw the hooks into somebody who claimed to have welded a worn flange without removing the tire. Mr. Foley declares that it can't be done and that the brother who wrote it is a hot air merchant, but we have been reparing broken flanges without **taking the wheels off the engine** for some time and have had no trouble at all in doing it.

We don't put any water or anything wet on the tires at all. We remove the rods to get at the job better and starting at the bottom of the flange, weld up. We have never had a tire loosen up so that shims would be required afterward, and have welded some that already had shims under them, and they didn't loosen.

We start welding at any place handy on the flange and go right on around, and we do nothing at all to the tire after welding. I like to read what any of the boys have to say regarding difficult jobs because I don't believe any of us get too old to learn. PAT McCARTY.

Progressive Industry quickly gives preference to the process which can show its advantages over other methods—the modern way is to do it electrically

Concentrated high heat efficiency, which immediately fuses the metal, is obtained by electric arc welding.



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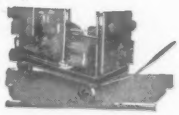

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Slow and laborious processes which retard production must give way to units that employ electric heat—and one of the most essential of the improved methods is *electric arc welding.*

Electric arc welding maintains advantages in quantity, quality, and cost—wherever iron or steel is to be joined in repair work, salvage, or original manufacture. The utilization of its possible applications extends over steel and iron works—boiler shops—foundries—repair shops—machine shops—and innumerable other industries.

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To stimulate correct operation, the General Electric Company has established an Arc Welding School at Schenectady, which offers exceptional training in horizontal, vertical, and overhead welding under actual production conditions—free to a limited number of men. Bulletin No. 48953 sent on request.

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Pressure Welding

EVERY person seriously interested in the future and welfare of the art of Autogenous Welding ought to know that the efficiency and stability of the art is in jeopardy. In a short time there will be a meeting of the Boiler Code Committee of the American Society of Mechanical Engineers and at that meeting, unless evidence to the contrary is produced, the Committee is apt to rule that fusion welding of unfired pressure vessels is unsafe. Such a ruling would be sure to be followed by drastic State and Municipal rulings, all of which would have a tendency to curtail the work of the Welder.

What is needed is a mass of authentic evidence relating to successful pressure or tension work, this evidence to be presented to the Committee. A committee of the American Welding Society (Chicago Section) is now working on this matter and the Committee is very anxious to hear from welders and manufacturers who have met with success in welding of this class. How many jobs of this kind have you welded and how many failures have you had? Could you furnish affidavits if necessary?

Particular attention is called to the fact that the Committee is anxious to hear from welders who have done perhaps only one such job, as this is evidence that a good welder can do pressure or tension welding, even though he has not been accustomed to such work.

The Development Committee of the Society is circularizing the welding industry with the following letter, and all manufacturers and welders who are able to supply information of value are urged to communicate with the Society:

"Do you know that the American Society of Mechanical Engineers is considering the adoption of a ruling which would practically eliminate the fusion welding of unfired pressure vessels as now practiced?

"Enclosed you will find a copy of the preliminary report of the Boiler Code Sub Committee of the American Society of Mechanical Engineers as considered at a meeting of that body at St. Louis in May 1920.

"Should this report be adopted as it now stands, fusion welding would not be sanctioned on vessels described under Class A, where the working pressure exceeds 15 lbs. per square inch. The ultimate tensile strength of a fusion weld in a vessel under Class B "which has been properly welded by the autogenous process" would be taken at 50% of the tensile strength of the plate.

"At the St. Louis meeting above referred to action on this question was deferred until December 1920 to give manufacturers of welded vessels within these classes an opportunity to present evidence as to the reliability of fusion welding. Unless such evidence is forthcoming there is no doubt but that this ruling will be adopted as it now stands.

"The Chicago Section of the American Welding Society has no axe to grind in this matter. We are not proselyting any one type of fusion welding or welding apparatus. But, as a representative association of users of the fusion welding process we firmly believe that fusion welding has reached a point where higher rating is entirely warranted than that indicated in the proposed amendment.

"We believe that the American Society of Mechanical Engineers are entirely fair in their attitude on this question and that if sufficient confirmatory evidence is at hand at the December meeting, fusion welding will receive the recognition that it should have. But to make this object attainable it is absolutely essential that we have concrete facts as to welding to submit to the Boiler Code Committee of the American Society of Mechanical Engineers in December.

"We therefore ask that you read carefully the enclosed questionnaire, answer it as fully as possible, swear to your statements before a Notary and mail to the American Welding Society, Development Committee, 608 South Dearborn Street, Chicago. Your answer will be treated entirely con-

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The Rivets Have Been Burned Out

CONSIDER the ease with which Oxy-acetylene accomplishes the most trying operation that comes to any ship-yard—repair work on framing and plating.

Compare this modern method of cutting out rivets, of severing frames, of sundering plating to the obsolete method of the cold chisel, drill and hack-saw. It's like comparing the craft of Columbus to the enormous ships of to-day.

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PW 505

fidentially, it will be used only for the purpose above stated and will not pass out of the hands of the Development Committee until it is submitted to the American Society of Mechanical Engineers.

"We earnestly request your serious consideration of the matter and hope for your entire co-operation as only by concentrated effort can there be prevented a serious setback to the whole welding industry."

Respectfully yours,

Development Committee.

AMERICAN WELDING SOCIETY, (Chicago Section.)

QUESTIONNAIRE.

1. Show the design by sketch or blue print of the unfired pressure vessels which you manufacture, indicating clearly the location of fusion welds.

2. Submit a statement as to your welding practice covering particularly the following points:

A: Preparation of joints and setting up work before welding.

B: Description of pre-heating methods, if any.

C: How is work held in position while being welded?

D: Angle or bevel, if any, on plate to be welded.

E: How is provision made for expansion or contraction?

F: Are joints welded from one or both sides of plate?

G: Do you anneal and hammer weld and if so at what temperature and how long do you anneal and at what temperature or color do you hammer the weld?

H: Submit description and if possible samples (preferably 6" long) of welding rods or electrodes used.

3. How do you ascertain whether an operator possesses the skill necessary to weld pressure vessels?

4. How do you train your welders?

5. How do you supervise your welding work?

6. Method of inspecting welds and testing welded pressure vessels.

7. Give a full statement as to the welded pressure vessels you have turned out since being in the business, giving a brief description of the welded work thereon, the total number manufactured, the number of which, you have any record as having failed in service and the causes for such failures in so far as you have been able to ascertain them.

NOTE—Above statements to be of value as evidence before the American Society of Mechanical Engineers must be in form of an affidavit acknowledged before a Notary public.

As stated in the letter of the Development Committee, should the report of the Boiler Code Committee be adopted as it stands, welding of vessels would be restricted as follows;

Class "A"

Vessels for containing liquids above the atmospheric boiling point, inflamable substances, or any gas, and limited in size to those over 6 in. in diameter, more than 1.5 c. ft. in volume and carrying over 15 lb. pressure per sq. in.

Class "B"

Vessels for containing liquids, the temperature of which are under control so as to be below atmospheric boiler point and limited in size to those over 9 in. in diameter more than 4 cu. ft. in volume and carrying over 30 lb. pressure per sq. in. but not to exceed 100 lb, pressure per sq. in. For pressures over 100 lb. sq. in. the rules for Class A vessels apply.

Information for the Committee should be addressed "Development Committee, American Welding Society (Chicago Section) 608 S. Dearborn St., Chicago Ill.

Get behind this worthy movement.

Concerning Welded Tanks

"THE manufacturers of rectangular welded tanks," writes a mechanical engineer in recent issues of *The Boiler Maker* and *The Welding Engineer*, "are apparently following the same designs for the staying as were used when tanks were riveted. The result is that the tanks fail by opening the welds at the corners, which soon commence to leak out and, not being repairable, have to be scrapped. Unfortunately there is no practicable way of repairing a welded joint."

Human expression falls easily into the general statement form, and it is not surprising that conclusions supported by superficial evidence are often in error, as there is always danger of confusing the exception with the rule. This appears to have occurred in the deductions drawn in the above statements. That the conclusions had for their basis only the weakness of an isolated instance, a solitary second-hand tank of a type made before special engineering study had been applied to welded tank construction, seems certain from subsequent statements in a letter written by the author of the original published article.

"I regret to be unable to say," writes the engineer, "which process was used in welding the tank mentioned in my article. This tank was used to hold the feed water on a steam shovel, and both shovel and tank were second-hand when they came under my attention.

"Speaking from memory, I should say the tank was about ten feet high, six feet long, by two feet six inches wide, of 3-16 inch plate, and of practically rectangular shape. The tank was open at the top, or rather I ought to say there was a hole about 18 inches in diameter in the top plate, and it was filled with water about once per day, and the boiler was fed from it as required. The pressure on the sides was only that due to the head of the water, that is, ten feet as a maximum; but the bracing was so badly designed that the bulging of the sides was quite perceptible when the tank was being filled."

In the words of a welding engineer to whom this letter was referred: "That is certainly the most superficial basis for damning an industry that has ever come to my attention!"

Of course the author-engineer had no intention of "damning an industry," as evidenced in another of his statements, to-wit: "This gives the welded tank a bad reputation—which it does not deserve, the fault being entirely with the weakness of the bracing." Basing his assumption that all welded tanks are poorly braced on the premise of the single instance cited, he proceeded with the development of a series of equations to determine the bracings necessary under varying conditions as to dimensions, materials and pressures.

The welding industry will not pass unchallenged the inference that weakness is inherent in welded tank construction. Quite a contrary position will be taken by those welding engineers who have specialized for some years past in the application of welding to manufacture of tanks. Welded tanks are being built very extensively in many parts of the United States, and they are at once so economical and so satisfactory that they are very largely displacing riveted tanks. They withstand very much greater pressures than the water pressure in the tank previously noted, and after proper test and inspection are accepted everywhere as the highest type obtainable in tank construction.

It should be made very clear, and it cannot be too positively stated, that welded joints can be repaired, and very easily and effectively by the welding process, though the occasion for such repairs, as welded tanks are now constructed, is practically non-existent.

The Human Element in Welding

MUCH has been said about the human element which enters into every welding problem. There are people who seem to believe that there is sure to be a given percentage of welding failures because of this human element. Yet these same people, when they go to a drug store to have a prescription filled, would be indignant indeed

3000

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if they were told that the man behind the prescription counter was apt to be looking out of the window when filling their prescription and that serious consequences might follow.

Doctor Welder has the same right to expect his prescriptions to be filled properly as the Physician who administers to mankind. The Registered Pharmacist knows that he must give close attention to his duties. If he does not do so his mistake may result seriously and he may loose his right to fill prescriptions. The Welding Pharmacist ought to be equally careful and if he is registered or licensed he ought to lose his license for poor workmanship. If this is not done then the skill of the famous specialist, Dr. Welder, is liable to suffer.

The Railroads and Autogenous Welding

COMMENTING on the activity of the Committee on Autogenous Welding, Mechanical Section, American Railway Association, the Railway Mechanical Engineer remarks: "There are committees, societies, manufacturing companies and individual engineers giving their best efforts to the development of the art, and the railroads should not only keep in mind all the possibilities of welding, but should also give their assistance to those who are working to make autogenous welding thoroughly and completely dependable." The Chicago Section of the American Welding Society has been organized on a well defined policy that seeks better welding, and is receiving at the start the support of railway men. It is one encouraging example of the general trend toward uniformly dependable results.

What Will the 1920 Graduate Do for a Living?

THE question, "What will the 1920 graduate do for a living," is answered for the thousands of young men who have qualified for the professions, and to a lesser degree for those other thousands who have completed technical courses; but there is a very considerable portion of the latter who will not at once find employment in the particular field for which they have prepared. For these and a great many non-technical and non-professional graduates the world of industry and business affords unnumbered openings. There is an insistent demand for the trained mind—the mind that has been taught to think clearly and logically.

Analysis will show that the more successful men as a general rule forge ahead because they make the right kind of a start. And oftener than may be supposed the right start is within the individual's own decision. One way to make sure of a right start is to enter an industry or business that is great in itself and that is young as well as great, in the sense that its vigor points to yet vaster development for the future. There are many such in the United States—mighty nation-wide industries that are in reality only giant infants growing up with the generation of young men today. These stalwart American companies keep their doors always open to young men who have the training, the purpose, the industry and the courage to develop real ability. Their business branches are easily accessible in every State in the Union, and the opportunities they offer are sufficiently varied to fit the cases of a large majority of 1920 graduates.

Young men of a mechanical turn of mind may find their niche in the factory and plant departments of these companies, in the foundry, the machine shop, the welding shop. Another class may enter the packing and shipping departments; yet another may go into the offices as bookkeepers, accountants, secretaries. For men of aggressive temperament the sales divisions present a special appeal. The science student may well find his place in the laboratory or in the engineering corps. Undoubtedly some might fill positions of higher responsibility. Those who have the fitness will rise to these positions. But the man who goes to the top in a great organization to-day is the man who personally knows its foundations and the successive stages of its structure, the man who knows the whole with reference to the essentials that constitute it. The untrained mind remains shackled to individual phases or elements of a business. The trained mind assimilates a wider range of things, recognizes the real forces and understands their relation to each other and to the whole. He steps out of the routine job into the administrative and executive realm. The trained mind achieves in a few years what the untrained mind can never attain.

The development of the oxy-acetylene and related industries is one of the romances of American business. Almost unknown fifteen years ago, it has become one of the stupendous achievements of the times. Carbide, oxygen and acetylene to-day enter into almost every branch of industrial life in the world. Their applications go hand in hand with the metals everywhere, and they are being constantly extended. Few fields of human endeavor afford greater opportunity for material advancement of the men in the industry and business of the country; few are so engaging in interest, so stimulating to ambition. In the great corporations at the forefront of the industry are thousands of successful men and no inconsiderable number who have amassed large fortunes. Everywhere in the organizations ability is given recognition and a merited reward.

BUREAU OF STANDARDS TEST

Editor: In the letter printed in your May issue, page 64, Mr. Philip Kearny says:

"It seems that one of them objects so strongly that it has endeavored through the American Welding Society to have the test stopped. As a member of the Society, I have failed to ever hear of any such action being authorized by it."

The Board of Directors of the American Welding Society advise that no member of this Society has ever been authorized by the Board of Directors, by the Executive Committee or by any official of the Society, to speak or act for the Society in any way in connection with the Bureau of Standards tests of torches.

Moreover, the Board of Directors is not aware of any request having been made to the Society or to any of its officials for any action in connection with the Bureau of Standards Tests.

In fact the Society has no official knowledge of these tests, or of how they are being made and, therefore, has no information on which to base an opinion.

AMERICAN WELDING SOCIETY,
J. H. DEPPELER, President.

OXWELD PUTS OUT "EVEREADY" INSTRUCTION BOOK

The new "Everready" instruction book put out recently by the Oxweld Acetylene Company, 3640 Jasper Place, Chicago, Ill., is one of the best treatises on everyday oxy-acetylene welding and cutting that has thus far been produced in the commercial literature of the industry.

The little volume is a compact and handy brochure (5 inches by 8 inches), containing 55 printed pages, inclusive of illustrations and drawings. Seldom has so much practical and useful information on the subject of modern practice in welding and cutting been brought within the compass of a ready reference booklet. It covers the field of everyday applications in a remarkably clear and concise treatment and in language that is easy for the beginner to grasp, and it is at the same time invaluable to the experienced welder and cutter.

The booklet is distributed free.

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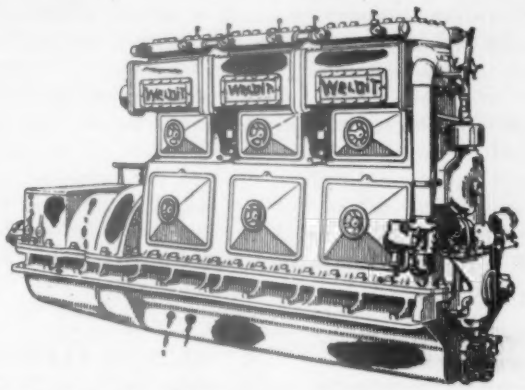

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Supplied in sticks about ½-inch diameter by 6-inch long; used by scores of foundries for patching bad spots in castings, and by welders for stopping leaks and finishing up poor looking welds. Any kind of heat that will warm the metal is all that is necessary.

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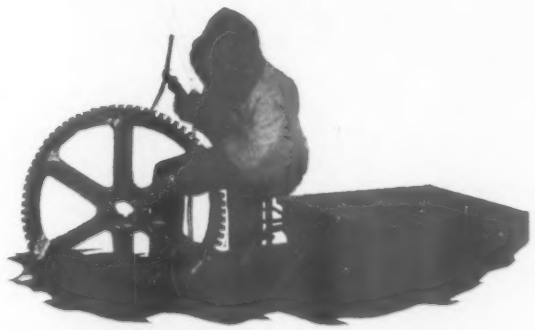

Bulletin 104

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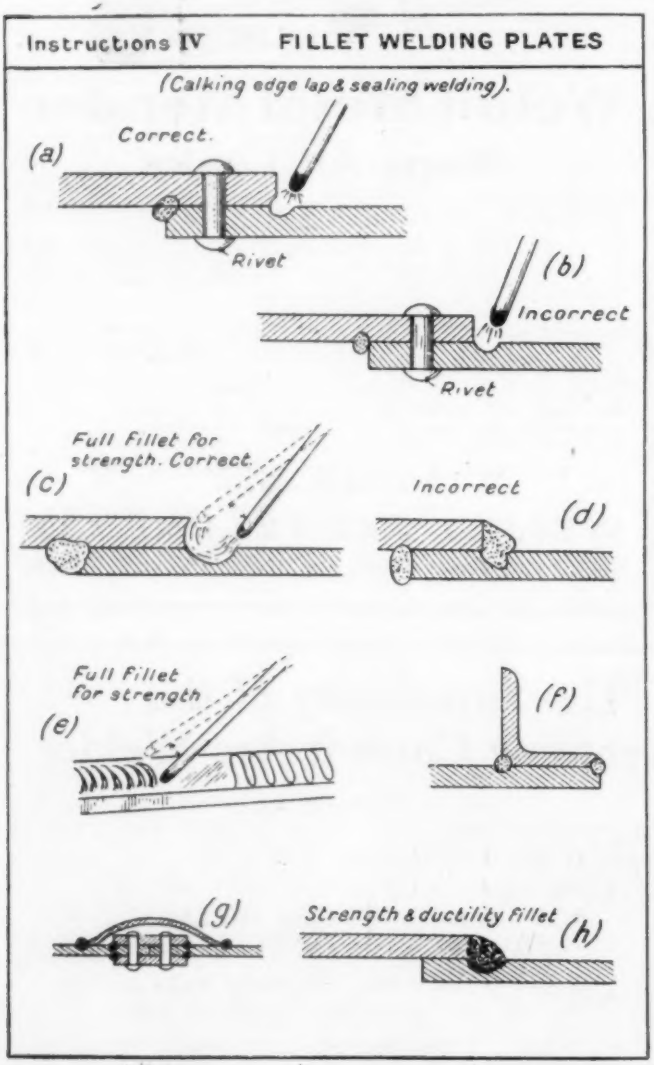
FILLET WELDING

Fillet welding is especially useful in sealing leaks in joints made with rivets, or by any other method, but care must be taken in case the joint is loose to make it secure and rigid before trying to seal with the fillet weld, because with the loose joint the entire strain is thrown on the fillet which, in general, is not of a cross section equal to the orinigal plate, and hence weld will be blamed for tightness failure where an entirely different cause was the trouble. If the joint cannot be made tight before welding, sufficient fillet must be added carefully to secure strength at least equal to the original joint.



It will be noted that in Figure A the fillet welding for tightness is simply single bead carefully run so that it sinks in equally in both plates. This can be accomplished practically by the arc being drawn directly over the crack to be sealed with the electrode held pointing slightly more towards the upper or vertical surface, as gravity will take care that enough metal from the electrode is deposited on the horizontal surface. If the electrode is held as shown in B, i. e., somewhat exaggerated, of course, a beautiful weld may be made to the horizontal face, but none to the vertical face, thereby not sealing the joint although the weld may apparently be solidly against the vertical face. This comes from the arc not having been drawn from the vertical face and hence no crater having been made there, and although the electrode may have been pointed towards the face it simply runs down lying against it without welding.

Figure C shows fillet welds made by spreading, i. e., the electrode is moved back and forth either side of the crack so that the arc is forced to follow, forming a trough alternatively in the horizontal and vertical faces into which the electrode material is to be deposited. This method requires more skill than the single fillet, or a succession of single fillets, but, on the other hand, is quicker for full strength fillets. The most reliable way of all is to make one single bead as shown in Figure A directly over the crack and then fill in for strength as shown in Figure C, advancing in such a manner that the bottom or horizontal part of the weld is always slightly in advance of the weld on the vertical face so that there is minimum danger of the molten metal running down and ahead of the arc. Figure E shows how this should be accomplished by a side view.

Figure D shows incorrect fillets with the metal overlapping, i. e., run ahead of the arc and with welds lying up against, but not fused into, the vertical face. Figure F shows the manner of successive short beads necessary to obtain ductility in the weld. This method is necessarily slower and must be done more carefully, but where the weld is made up to resist bending strains, there is much greater chance of obtaining the necessary ductility than with the method shown at C, although the combination method of A and C, as described above, will give ductility of the sealing bead but not the second and final layer. In order to have the final layer reasonably ductile, even with the metal shown in Figure F, an additional layer should be added at generally a higher current value in order to anneal the entire mass. This additional layer for fillet welding must, in general, be left in place, as it also adds additional strength, and whether the fillet is slightly larger makes no particular difference, unless for jobs where fit is necessary, in which case it can be machined off. In machining a weld, sufficient annealing layer should be added so that as little as possible of the weld on which strength and ductility depend is to be removed.

The welding of boiler tubes after they have been rolled, beaded and often proceressed, is the most prevalent example of a single bead fillet for tightness only. Here the tube is secured in place to start with, even when a new tube is put into an old flue sheet, generally a ferrule of copper is put in between the new tube end and the old sheet to allow for the difference in size caused by the first or previous expansion. When a copper ferrule is properly applied, none of it sticks out beyond the bead, but even if irregular pieces do stick out the sealing weld can be made as usual, as a reasonable amount of copper fuses well with the steel of weld, bead and sheet. The proper cross section of the tube sealing bead should be egg-shaped with the large end welded in, and there is no need of chipping off the small protruding end, as experience has shown that no scale or soot results. In rolling and beading tubes, oil is used, and this oil must be burned out of the sheet so it is out from under the bead, or in welding the oil gas will bubble out through the weld, causing leaks and no job. The edge of the bead and flue sheet should be cleaned of scale by chipping or sand blast, the latter being the better, but not always available.

A heavy fillet, i. e., one that cannot be made in one bead, can be easiest and most reliably made by welding vertically from the bottom up, the bead into the two plates or surfaces of the fillet sides being welded first, following across the weld one layer behind the advance into the work surfaces. If the reverse method is followed there is danger of metal running down ahead of the puddle into the pocket of the V.

**Instruction No. 4, from the handbook of the Electric Arc Cutting & Welding Co., 222 Halsey Street, Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each. Previous chapters were published in Feb., Mar. and April, 1920.*

CHICAGO SECTION AMERICAN WELDING SOCIETY ORGANIZED

An organization meeting of the American Welding Society, Chicago Section, was held Tuesday evening, August 3rd, at the rooms of the Western Society of Engineers, Chicago. The object of the association, as adopted in the By-Laws, shall be to promote the science and art of welding and its accessory operations. The program for attaining this object includes the reading of papers, discussions, exhibition of plans and photographs, moving pictures of undertakings planned or executed and the free exchange and publication of professional ideas. Research work within the limitations of the funds available for that purpose may also be carried on.

About seventy-five members were present at this first meeting. Following informal talks by Professor C. A. Adams, Dean of School of Engineering, Harvard University, and W. E. Symons, Treasurer, American Welding Society, a set of By-Laws was proposed and adopted. The following officers were then elected:

Chairman—M. B. Osburn, Assistant Superintendent, Pullman Car Works.

Vice-Chairman—O. T. Nelson, President, General Boilers Co.

Secretary-Treasurer—L. B. Mackenzie, Publisher, *The Welding Engineer.*

Directors for three years:

E. Wanamaker, Electrical Engineer, C. R. I. & P. R. R.

H. B. Bentley, Superintendent M. P. & M., C. & N. W. Ry.

W. A. Slack, President, Torchweld Equipment Co.

Harold Cook, Managing Editor, Acetylene Journal.

Directors for two years:

Andrew Oliver, Welding Supervisor, Standard Oil Co.

W. M. B. Brady, Consulting Engineer, General Electric Co.

K. R. Hare, District Manager, Transportation Engineering Co.

J. M. Jardine, Western Welding & Equipment Co.

Directors for one year:

W. H. Bleecker, Jr., District Manager, Page Steel & Wire Co.

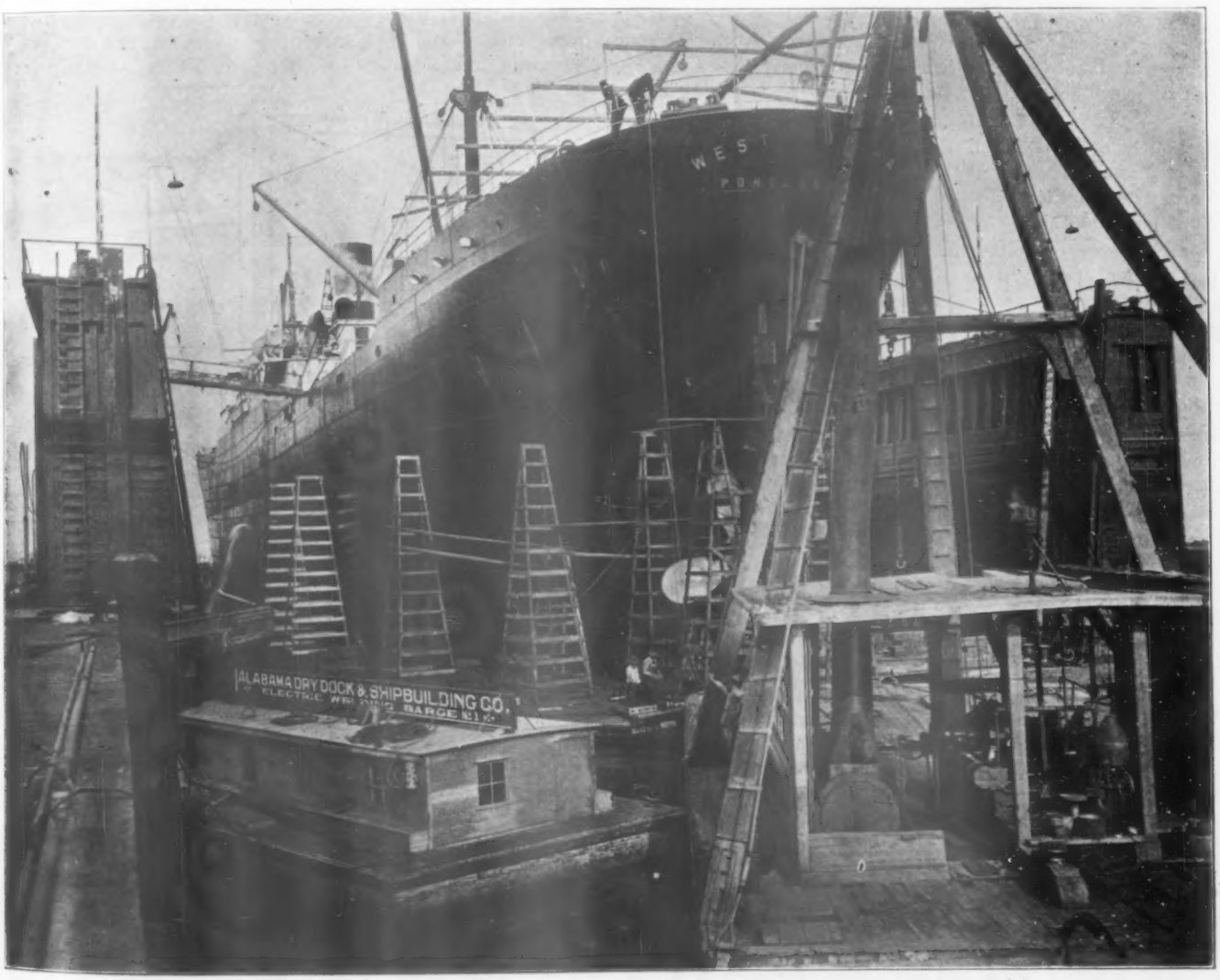
Oliver Mitchell, A. F. Mitchell & Son.

Walter L. Senhert, President, Chicago Welded Products Co.

Don B. McCloud, Secretary, Gas Products Association.

OXWELD OPENS SAN FRANCISCO OFFICE

The Oxweld Acetylene Company has established Pacific Coast sales and distributing headquarters at San Francisco, with offices at 1077 Mission St. Additional sales representative's offices are maintained at the following points: Los Angeles, 646 Maple Ave.; Salt Lake City, 908 Kearns Building; Portland, 90 First St.; Seattle, 433 Pioneer Building. Mr. Leo Romney, with headquarters at San Francisco, is Pacific Sales Manager. The territory embraces the states of Washington, Oregon, Idaho, Utah, Arizona, California, Nevada and the counties of Lincoln, Sweetwater and Uintah in Wyoming. This territory was formerly served from Chicago and Los Angeles.



Welding Barge of Alabama Dry Dock & Shipbuilding Co. Two of These Barges Are Operated.

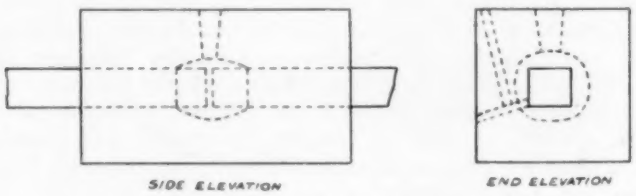
TENSILE STRENGTH TESTS OF THERMIT AND ELECTRIC WELDED TIE RODS.

During the month of August the Algona Steel Corporation, Ltd., Sault Ste. Marie, Canada, had a rush job to do in the way of welding some 13 pieces of 3¼ inch square rods, each rod to be welded in 3 places making a total of 39 welds.

These rods were used as tie rods from a concrete ore dock back to an anchor wall, making the rods in all a length of about 185 feet.

The nature of the sub soil and the excessive loads of ore placed in storage back of the dock proper made it necessary to get a substantial tie back to prevent any slip in the dock.

Rods were placed at an elevation of about 3 inches above the normal lake level but due to high water in the lake at the time the work was going on the rods were frequently submerged and the work had to be rushed during the periods of lower water.



Position of Thermit Mold on Bar.

The first seven or eight welds were made by the Electric process and one of these welds cut out and tested the result of which was as follows:

	Tensile Strength per Sq. In.	Elongation.
Section of original bar	60,100 lbs.	40%
No. 1 Test on Electric Weld	18,700 lbs.	0%
No. 2 Test on Electric Weld	13,280 lbs.	0%
No. 3 Test on Electric Weld	16,500 lbs.	0%

or an average of 16,160 lbs. which was only about 27% of the original bar, and as 65% was necessary the Electric welds were condemned and all cut out and the Thermit weld used in its place.

Sample thermit welds were made out of a piece of 3¼" square bar and the tests obtained on this sample were as follows:

	Tensile Strength per Sq. In.	Elongation.
Original Bar	48,560 lbs.	52.5%
No. 1 Thermit weld	27,500 lbs.	2.5%
No. 2 Thermit Weld	52,200 lbs.	6.0%
No. 3 Thermit Weld	44,880 lbs.	4.0%

or an average of over 85% of the original bar.

In connection with these thermit tests, sample one had a slight pipe in it which reduced its tensile strength considerable but sample test was an almost perfect weld and tested up stronger than the original bar.

In preparing the sections for the tests of both electric and thermit welds, a piece of the 3¼" square rod about seven inches long containing the weld was cut out. This was put in a crank shaper and machined to flat surfaces on three sides, then put under a power hack saw and quartered. Three of these quarters were then turned down to test pieces having cross sectional area of 0.7854 square inches or about 7½% of the original bar.

The results of the tests made were so satisfactory that it was decided to use the Thermit weld in spite of the difficulties to be encountered. Boats were due at the Dock any day within a week and the water was high with not sufficient time to properly cofferdam each weld, however, by the use of a steam pump and constant bailing, the water was kept low enough to get at the welds and work started on July 9th, and was completed on July 17th, with the following results:

July 9th	3 welds
" 10th	3 "
" 11th	5 "
" 12th	5 "
" 13th	5 "
" 14th	5 "
" 15th	5 "
" 16th	5 "
" 17th	3 "
Total	39 welds

Some delay was experienced at times due to high water and also to shortage of air for preheating.

The accompanying sketch shows roughly a mould in place on a bar.

About 40 lbs. of Thermit were used to each weld and the preheating took about two hours to each weld.

The force employed on this work consisted of Charles Fosberg and six men.

NEW COLLAPSIBLE FORGE

The Wright Bros. Boiler & Machine Co., of Ranger, Tex., have developed a new collapsible or "break-down" forge that is coming into extensive use in the southwestern oil fields. The forge is designed for oil field tool workers, who find portable equipment very desirable owing to its compactness and the ease with which it can be set up wherever and whenever needed.

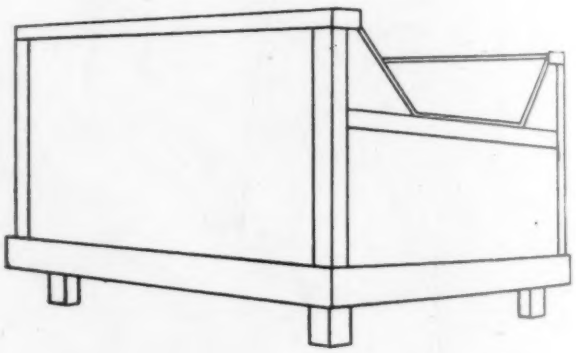


Fig.1 - Collapsible Forge - Set up for work

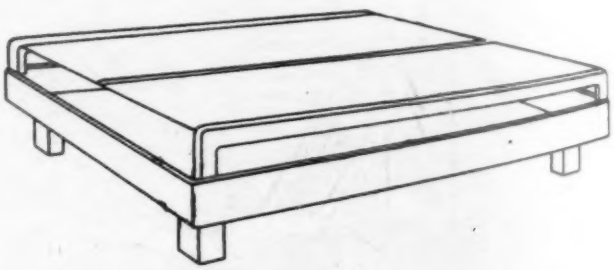


Fig.2 - Collapsible Forge - Knocked Down.

The new forge is being built on a production basis in the shops of this company as a side issue to its regular business. The entire manufacturing operation, which consists simply of cutting metal sheets to pattern and welding of the joints, is done with the oxy-acetylene flame, and the equipment required is almost as simple and compact as the forge itself.

WELDING BEVELED GEARS.

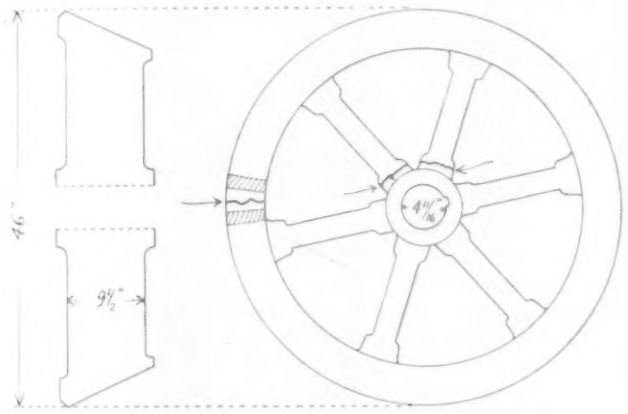
By D. S. Meyers.

RECLAMATION of broken castings and parts has in these modern days become quite common. The Oxy-Acetylene process is playing a prominent part in this important work, if not the most prominent. Many welders have contributed a "write up" which has been published in some of the industrial magazines, thus helping some other fellow to improve his methods and incidentally to further the process in general.

Personally I have been connected with the line about nine years and have not up to the present, written a single article. I am about to donate my bit.

This article is written for the benefit of the younger craftsmen, rather than for older members of the trade. The actual welding operations described were not of a difficult nature; but were really easy of accomplishment. The difficult part of the job was in the handling and preheating with the equipment at hand.

Two portable outfits were used to do the welding, including two 22-inch torches, which were the longest we could scrape up. However, by starting the job right, it was carried to a successful finish, showing conclusively that things generally can be done even under extreme difficulties.



Preheating Was Done by Means of a Built-up Brick Furnace.

Early in June of the present year, I had a call from a local cotton manufacturing company to go out to one of their several country plants and view a break-down job and report to them whether the fractured part could be successfully welded. Arriving at the plant I was shown into the wheel house, located over two 75 h. p. turbine water wheels. These wheels drive onto a horizontal shaft through cut bevel gears. One gear approximately 46 inches in diameter and weighing 900 pounds had two spokes broken, right at the hub, and the rim cracked through. Now while I have welded quite a large number of wheels and castings that were larger than this one; they have all been done in the welding plant with proper equipment and experienced help; but this individual job must be done on the premises. It took "the wind out of my sails" so to speak. However, I decided to take on the job and carried it out as follows:

The building available was the company smith shop, a low-roofed, 10x16-foot frame building, having one door facing the south. (Note this). A heavy piece of pipe was placed overhead to carry a chain hoist. The gear before being placed for welding, was chipped out by hand in the usual manner. On the day that this work was done, I noticed that the wind was blowing from south to north and I accordingly placed the gear upright and in such a position that the wind would blow on the backs of the operators, while welding; this procedure kept the heat out of our faces. The wheel was placed upright in such a position that two welders could work simultaneously on two spokes. A brick furnace was built oval around the wheel and to the top of the hub. The furnace was then filled to slightly above the hub with charcoal and lighted on top on one side and on the bottom on the other side; this to heat evenly.

The whole was now covered with sheet iron and asbestos paper. About 2½ hours was consumed in heating. When the wheel was ready for welding, holes were punched through the paper and a piece of sheet iron was laid on the furnace top, resting on the gear hub; on this was placed several layers of asbestos sheet and wet burlap was at intervals placed over the paper; this relieved us of some of the intense heat while welding. The welding proper began at the hub, both welders working at the same time. Two spokes having been welded on one side, the wheel was rotated about one-sixth of a turn and the spokes were then finished on the opposite side. The furnace was now torn away and the wheel dropped into the fire and allowed to remain 30 minutes before welding was resumed. The next operation consisted of welding the edges of the spokes. This part of the work completed, the wheel was raised until the rim was in a horizontal position, when the rim was welded full on the under side. The last operation consisted of welding the rim between the teeth, which was done by turning the gear over and again raising to a horizontal position. The welding completed the wheel was lowered into the fire, covered well and allowed to cool.

The wheel has been back in service for a number of weeks and the company has long since paid for my services. The heavy work not only pays; but advertises your business as well.

OIL MEN WITNESS WELDING TESTS

The big gas show at Buffalo brought together men in all branches of the industry from every part of the country. In the course of informal discussion on oxy-acetylene welding of oil pipe lines, a big Kansan questioned the strength of the welded line to hold up under the service pressures in his field. Of course there was abundant instances where welded lines are in service in oil districts, carrying pressure of 800 to 900 pounds; but the skeptic was not entirely satisfied. What he wanted was a breaking pressure test to determine just where the welding pipe would give way under breaking strains. In his opinion the break would occur in the weld.

The discussion was staged, as it happened, in a stronghold of oxy-acetylene welding. One of the factories and machine shops of the Linde Air Products Company is located in Buffalo and it is there in their big Buffalo Laboratory that Development Department engineers of the company conduct their experiments and tests in working out application problems for users of oxygen and acetylene in welding and cutting. This circumstance led to a series of tests to finally settle the matter in the minds of those concerned.

The Linde engineers first welded together two short sections of standard 3" iron pipe, threaded the ends and screwed on two standard cost iron caps. When the cold water pressure test was applied to the breaking point it was found that the top of one of the caps had blown out, leaving the pipe and the weld intact. The undamaged cap and the remaining portion of the broken cap were then removed and two extra heavy iron caps let go, still without injury to the weld or the pipe. Again the uninjured cap and remnant of the broken one were taken off and extra heavy steel caps screwed on. This time the caps held, but the pipe split and ripped under the added pressure upon passing its elastic limit, tearing up to and being effectually stopped by the weld, which refused to give. The pipe was distinctly bowed out at the rupture.

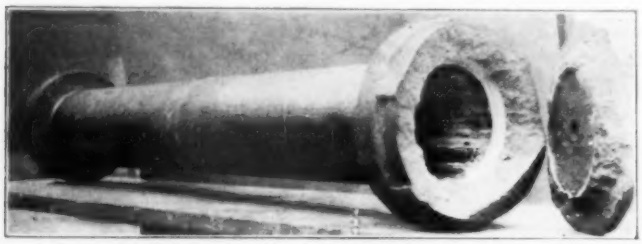
The next test was made with 4" pipe. Two lengths were

welded together as in the 3" pipe, the ends threaded and two extra heavy standard caps screwed on. In this test one of the cap heads blew out at, 4,400 pounds, which gave a total end pressure on the cap of approximately 33 tons, proving that the broken cap was not in any respect defective. The weld was not impaired at all. After this

Welded 4-Inch Iron Pipe—Extra Heavy Steels Caps Screwed On—Pipe Gave Way in Thread at 4,200-lb. Pressure—Weld Held Perfectly.

test it was suggested that an entirely new weld with other pipe lengths of the same diameter be tried. Accordingly, two more lengths of 4" pipe were welded, threaded and sealed, this time with extra heavy steel caps made to withstand a working pressure of 3,000 pounds of air. The pressure was applied and the pipe gave way in the threads at 4,200 pounds. In all of the tests the welds held securely.

The gentleman from Kansas decided that if there is anything stronger than a good oxy-acetylene weld it is not



Welded 4-Inch Pipe—Extra Heavy Standard Cap Gave Way at 4,400-lb. Pressure—Weld Not Impaired.

needed in the oil fields of the Southwest. He examined a large number of welded pipe specimens that had been subjected to hydrostatic breaking tests, finding that in no instance had the pipe given way at a weld.

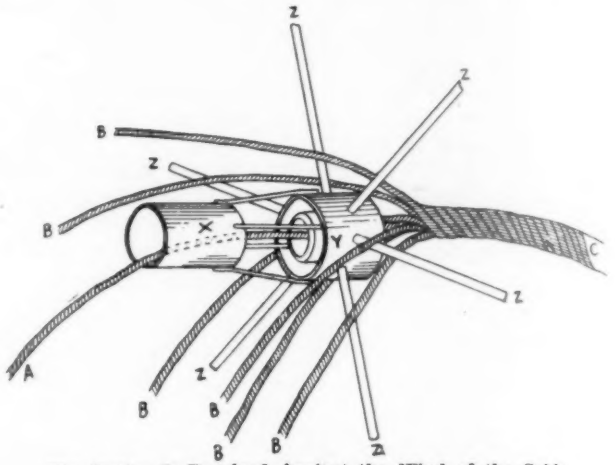
Oxy-acetylene welding of oil pipe lines, gas and water mains and laterals is increasing daily in all parts of the country, and it is more and more being specified in preference to riveted and threaded construction.

SIMPLE DEVICE FOR STRIPPING OUT INNER STRAND OF STEEL CABLE

An interesting salvaging operation was recently carried out very successfully by the Spanish-American Iron Company in Cuba. The inner strand of a three inch steel cable which had been condemned and discarded because of worn and frayed outer strands was salvaged and the worn strands cut into six-foot lengths for the charging box. Both the inner strand and the scrap were well worth saving, as the cable was a mile and a quarter in length and the reclaimed strand (1¼" in diameter) was practically as good as new.

The problem involved was to cut away the six worn strands without damaging the valuable inner strand. This was accomplished by means of a simple but ingenious device constructed on the ground out of convenient scrap metal. Suitable lengths of iron pipe, of a size convenient to grip with the hand, were welded into the rim of a small iron pulley in such manner as to resemble spokes in the hub of a wheel with tire and felloes missing. A short section of sheet iron pipe, slightly smaller in diameter than the pulley but larger than the shaft bore, was then welded to it in line with the bore by the use of four strips of strap iron.*

The strands of the cable were then pried apart for a few feet to admit passing the inner strand thru the hub and its extension and feeding the outer strands thru the six spaces between the spokes. With the strands so adjusted the device was revolved against the wind of the cable and advanced as the strands unwound, the inner strand being allowed to lie in a continuous length along the course of the work and the worn members being easily cut into charging box size with the oxy-acetylene torch. The length of the spokes gave the necessary leverage for hand operation of the device. The cable of course remained stationary,



The Device Is Revolved Against the Wind of the Cable.

the inner strand being coiled and the scrap collected after the work was completed. The job was done in jig-time, the oxy-acetylene flame snipping off the worn strands with almost chopping speed.

The device is developed in detail in the accompanying figure. "A" represents the inner strand of the cable "B" the worn outer strands; "C" the body of the cable; "X" the pipe extension of the hub; "Y" the pulley used as hub; and "Z" the spokes. It was made with practically no cost for material, being composed entirely of scrap, and with little outlay for labor. It affords an interesting example of the resourcefulness of the American mechanic, John Cranford, who was in charge of the work.

The use of oxy-acetylene cutting made simple and inexpensive an operation that would have been prohibitive by any other mechanical means, as it was equally out of the question to carry shears of sufficient power to the work or to convey the work to the shears. Thus, the salvaging was accomplished with dispatch and economy, netting the owners of the cable a handsome profit on the material.

** "The use of the pulley and pipe extension was necessary only because a suitable length of pipe was not at hand. A single section of pipe of the right size to allow for welding in the spokes and long enough to keep the inner strand from curling would be much simpler and would serve the purpose equally as well.*

SPECIAL INFORMATION SERIES

For the benefit of users of Everready welding and cuting apparatus who desire special information on any particular phase of the industry, the Oxweld Acetylene Company, 3640 Jasper Place, Chicago, Ill., announce a series of small printed instruction book and catalog. Among the subjects ready for distribution are:

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Electric welding has become so important an art in the mechanical industries that a comprehensive treatise on this subject covering both the resistance and the arc welding processes is needed in the trade. A special study of the subject has, therefore, been made by the authors of this work, who have been assisted in their work by the experts in resistance and arc welding of some of the most prominent concerns in the United States engaged in this line of work.

Consultations with the experts of these companies have made it possible to obtain thoroughly up-to-date information embodying the latest developments and discoveries in the art, and it is believed that, for this reason, the book will prove especially useful to those who are already employing electric welding equipment or who are contemplating its use, as well as to the students of the subject who desire to obtain authoritative information on the electric welding processes.

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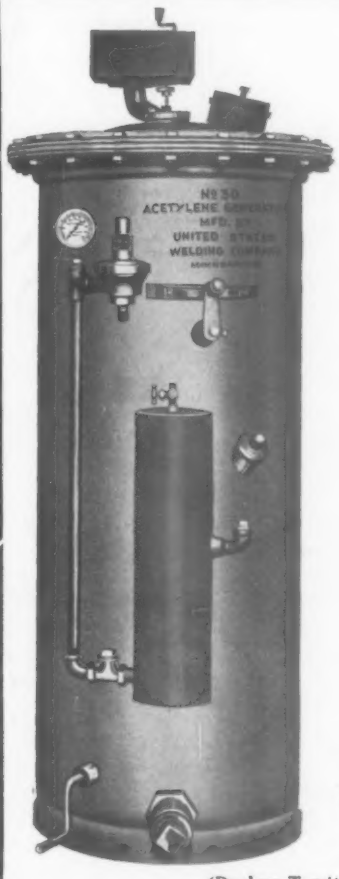

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PORTABLE EQUIPMENT FOR WELDING GAS MAINS

By C. W. Geiger

The weldihg by the oxy-acetylene process of the butt ends of the high pressure wrought iron pipe of the Pacific Gas and Electric Company's high pressure gas mains, as developed by Mr. L. B. Jones, former Assistant Engineer of the Gas Department, has proved itself so satisfactory that no substitute is even given a thought, and today oxy-acetylene welding is used exclusively.

Previous to the use of the welding process high pressure mains of the Pacific Gas and Electric Company were installed and the lengths of pipe coupled together with couplings and rubber gaskets. Due, however, to the disintegration of the rubber gasket by the gas, couplings proved an expensive and unsatisfactory joint, so that other methods of joining the tubes together had to be found.

Following the initial work of Mr. L. B. Jones, and after exhaustive tests, the problem was solved; with the result that instead of using couplings the pipes are now welded together with the oxy-acetylene process, creating a permanent joint at considerably less cost, and requiring no further maintenance. The pipe for welding is purchased with chamfered ends, and so when butted together a V is formed, The welder works on top of the ground alongside of the trench. With the oxy-acetylene torch and a stick of wrought iron he proceeds to heat the pipe ends and melt the stick of iron which builds up on the pipe ends. He goes completely around the pipe; usually the pipe is turned as it is more convenient to make the joint on top. But when necessary, the welder works the joint up side down.

The entire system of gas distribution at the recent Panama-Pacific Exposition in San Francisco was through pipes with welded joints. The gas supply to what is known as the *Reading District* is through an 8-inch high pressure line thirty miles long, every joint of which was welded. Between Santa Rosa and Petaluma there are over twelve miles of welded pipe. In Fresno, Sacramento, San Rafael, Oakland, and San Francisco every bit of high-pressure laid in recent years has been welded.

Some idea of the tensile strength of the welded joints may be gained from the fact that six lengths of 16-inch pipe, each twenty feet long, were welded together over a trench, the last length, weighing 1,000 pounds, was not supported in any manner, practically hanging on a welded joint. No attempt was made to lower the pipe carefully; on the contrary, it was just dropped in the trench. This was done as a further test and to bring out any possible defects, it being infinitely better to ascertain any defects before the pipe was covered.

The portable welding outfit consists of an acetylene tank at 300 pounds pressure and a capacity of 500 cubic feet of acetylene, and an oxygen tank with a capacity of 100 cubic feet of oxygen at 250 pounds pressure, together with reducing governors, gauges, tubing and welding torch. This equipment is carried on a three-wheeled truck, which is provided with a handle to pull it around by.

The pipe laid between Santa Rosa and Petaluma was standard 4-inch black steel, 9.4 pounds per foot, ends chamfered at 45 degrees, 19- to 20-foot lengths. The chamfered ends replaced the usual threads on the pipe and made possible the better welding of joints.

Before actual pipe-laying started on this section, it was necessary to educate a welder. This was accomplished by furnishing a man with equipment consisting of torch, gas and pieces of pipe, permitting him to play, or struggle, with same until the art was mastered. It took about ten days of such student work before he was proficient enough to be trusted with the actual work of joint-welding on the gas line. In the meantime the trenching machine was busy excavating. By the time actual welding had started about 2000 feet of ditch was open. With this handicap the trencher could not keep ahead of the welder, for though he started at the rate of three joints per hour, practice soon brought this up to six and sometimes seven.

EXAMINATION OF WELDERS

Editor: The letter recently written by P. W. Westfall I think is a good one; it gives us something to think about. To my notion there should be some way for every welder whether electric or gas to get his card, not by simply applying, but by examination. He might take this examination from some institution that is competent to give it, or from questions made up by some organization and sent to the applicant on request, to fill out before an examiner. I also think the applicant should be required to demonstrate on different metals. Of course this is only a suggestion of mine. There must be some way to get good welders and good welders we must have to protect the trade. When a man just drops the filler on the job and calls it a weld, it certainly is disgusting to hear a customer or an outsider run down the welding craft. Of course the best welders are sure to make occasional mistakes and get poor results, but as a rule the jobs done by the good welder are O. K., if not they will be made so. But when the operator does not possess the necessary qualifications the weld cannot be satisfactory. I would like to hear from some of the welders through The Welding Engineer on this subject. The only way to get results is to discuss them.

Yours for welding,

R. H. ANDERSON.

ELECTRIC WELDING

Editor: In a recent issue of *The Welding Engineer* I noticed an inquiry for a remedy for cracking superheater tubes and side sheets, also door nicks. I am a first-class electric welder and can give you one reason for this trouble. There is an old saying among some welders that there is no expansion or contraction in steel welding. This may be true but I doubt whether any of these men who hold responsible positions with the railroads ever stop to think that when they push their men to produce as much welding as they possibly can so that a man welds on the average of eighteen or twenty feet of firebox a day, the constant heat not only crystallizes his filler metal but also deadens the temperature of the metal he is uniting. I have heard that the heat of electric welding should not be applied to a job longer than ten minutes out of every fifteen. Railroads today are trying to weld cast iron cylinders without the weld lifting; they cannot do it because they weave their metal instead of running it in large thick beads. One company in the west makes a specialty of heavy cast iron welding and nine times out of ten they make a success of it

You cannot, however, electric weld eight hours out of eight or nine and make a successful job.

J. E. BAXTER.

NEWS ITEMS

The M. J. Skubal Co., Milwaukee, Wis., has purchased the welding business from the Electric Welding & Mfg. Co., of that city. The latter firm was under the control of Mr. M. J. Skubal prior to the war.

Several manufacturers of welding equipment and supplies have taken large space in the Foundrymen's Convention which will be held in Columbus, Ohio, October 4th to 9th, and which promises to be an important event. The welding concerns will be grouped in Building No. 6.

WELDING PINCER
MODEL 3
Price, $1.50

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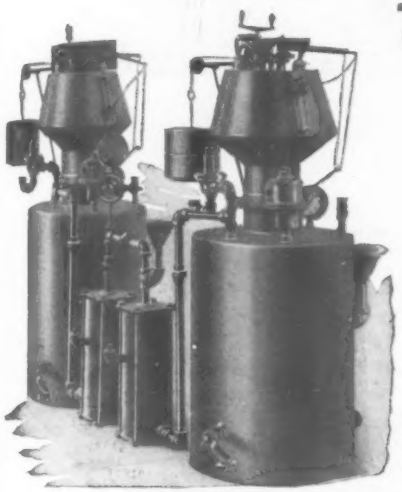

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Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 5,000 other readers of The Welding Engineer (you're the fifty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

If the welding industry is to grow, you welders must pass along your experiences. We pay for them.

THE WELDING ENGINEER
608 S. DEARBORN ST., CHICAGO

SOME THINGS EVERY WELDER SHOULD KNOW

Due to the increasing popularity of a preparation recently placed upon the market by a company well known to the welding trade, additional instructions of a very interesting nature are being distributed.

Believing that everything new, which tends toward the advancement of welding in general, and which will advance the industry as a whole, should be given prominence, the following article is presented. Particular attention might be

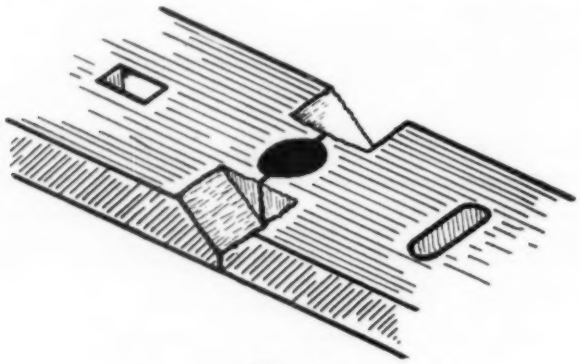

Fig. 1.

called to the construction of welding tables, their uses, etc.

Welders' Moulding Compound is placed upon the market in a dry powdered form and for convenience in handling is always packed in five pound cartons. When mixed with water to the consistency of dough and then heated, it becomes practically fireproof. On this account, it is used extensively with the various welding processes to assist the operators in saving time, material, extensive machine work, and permit the execution of better and more difficult welds. There are many times when it is possible for a welder to rough out a

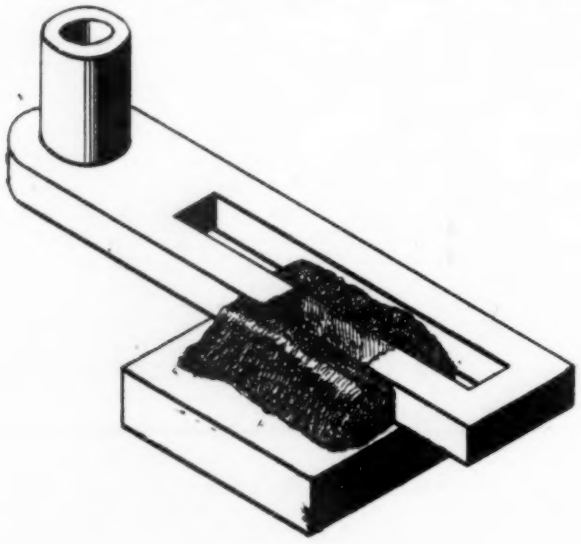

Fig. 2.

certain missing part or build up a worn spot in a fairly good manner and then after the casting has cooled down grind or chisel the welded portion to size. It will be appreciated that this requires considerable time, not only for the cooling but the machine work as well and it must be remembered that machine work can only be done when the welded part is soft and free from blow holes, otherwise the tools will be ruined. How much better it is to use Welders' Moulding Compound and save all this time, make a better looking job, be able to charge more for it, and have a better satisfied customer.

The purpose of Welders' Moulding Compound is not to offer a better fire resister than the ordinary carbon rods and blocks which have a limited use, but rather to open up a much wider and broader field of application. The illustrations with this article are offered as a few suggested applications where Welder's Moulding Compound can be employed. To name the many instances where this compound can be fittingly used to advantage would require much space. Realizing that conditions naturally vary in many shops where welding is done and that in a great many instances no two welding jobs are ever alike, it is intended to cite only a few applications here to give the operator a general knowledge as to its possibilities and then let him depend upon his own initiative to use it as his particular case requires.

We have an ordinary cast iron bar broken through a round hole. It would be possible to make a template, mark the position of the hole, execute the weld, and then drill another hole but it would be much simpler to fill the hole with Welders' Moulding Compound, after it had been prepared as shown in Figure 1, make the weld and the piece would be all ready for use. A square hole and one of an oval shape are shown which would not be quite so easy to reclaim as the round hole if machining were neces-

Fig. 3.

sary, but they can be just as easily saved with the Welders' Moulding Compound. Again, if this center hole were threaded, the compound could be forced into the threads and the threads saved if due care is taken. In this respect it is best to prepare the weld as shown in Figure 1 and when the metal is molten work it up to the mould with the filler-rod rather than play the flame or arc directly on the mould. It must be remembered that the oxy-acetylene flame and electric arc give off over 6,000 degrees Fah., enough heat to melt any metal, therefore carbon and the usual fire resisting elements will recede to a greater or less extent before this powerful medium. Better results will, therefore, be obtained if most of the work around the mould is done with the end of the filler-rod.

At times parts of machines are brought to the welder for repair and there are pieces missing. By placing the part on a fire brick and moulding the compound as shown in Figure 2, and firing with the torch (to bake) the missing part can be very easily supplied and a finished job executed very rapidly.

There are many welders of cast iron who would not think of plunging their hot weld in cold water for fear of chilling it and making it brittle. Yet these same welders will be found using a heavy metal slab as a face plate to line their work up on. Their welds will be hard, brittle, and full of blow-holes for they are unconsciously chilling their weld. If they will notice closely, they will find that the minute the torch is removed, their weld will turn black, showing that the heat is being conducted away as the arrows in the figure would indicate and the same result is obtained as when the weld is plunged into cold water. In both of the preceding cases chilling is occasioned by rapid cooling. It is possible to overcome much of this trouble and at the same time keep the work in alignment by covering the metal slab with asbestos paper.

While most welders concede that the fire brick top table is the logical one for the welding shop it is not as popular as it should be on account of the difficulty experienced in lining up the work. The use of shims and other mediums to accomplish this end is not entirely satisfactory. By using Welders' Moulding Compound however, all of these troubles will be quickly overcome. If a broken casting is to be placed in alignment, a few fire bricks can be scattered about the welding table and daubs of Welders' Moulding Compound placed on each brick as shown in Figure 3.

The work is then placed upon the compound which acts as a cushion and if one part is too high or low, a straight edge will soon show where the trouble is, and that part raised or pressed down to conform with the other part.

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MANGANESE ADDITION INCREASES LIFE OF THERMIT WELDED WOBBLERS.

Successful results obtained from a considerable number of welds made by several large steel mills have shown, according to a statement by the Metal & Thermit Corporation, New York City, N. Y., that the life of wobblers on pinions, rolls and large shafts which have been repaired by Thermit welding, after previously having been worn away or broken, can be materially prolonged by the addition of 3 per cent pure Manganese to the railroad Thermit in addition to the 1 per cent of pure Manganese already in the Thermit. This will give a hard wearing surface.

Wobblers should be thoroughly heated to about 1400 degrees Fahrenheit before welding; otherwise no amalgamation of the two metals will be obtained.

•The Metal & Thermit Corporation, New York, N. Y., has made arrangements to secure life insurance for all its employees who have served the Company for at least six (6) months. The amount of protection is graded according to the length of service, ranging from $700 for six months service up to $3000 for twenty years' service. The Company bears the entire expense of this insurance, which is in addition to any compensation to which its employees might be entitled under the present State Compensation Laws. The insurance will be paid in monthly payments during the first year after death.

QUASI-ARC PROCESS WELDING

A descriptive pamphlet issued by the Quasi-Arc Weldtrode Company gives a detailed account of the Quasi-Arc process of welding and a set of instructions sufficiently full to give the reader a clear idea of the nature of the work it can best accomplish. This process is a fusion process, the weld being obtained by the autogenous union of the metal. The highly-localized heating agency of the electric arc is employed to bring about autogenous union, the fusion starting immediately the arc is struck, and under such conditions, it is claimed, that throughout the whole operation the fused and adjacent metal is entirely protected from all oxidizing influences. This result is obtained by the use of patented electrodes in conjunction with patented methods of application. For the general welding required in engineering works, shipyards and steel foundries the only requisites beyond the special electrodes are a simple electrode holder, a supply of current, either direct or alternating, at a pressure of about 105 volts, and a suitable resistance for regulating the current. This welding process can be used to advantage in engineering works, shipyards, boiler shops and steel foundries for a variety of purposes. The ease with which seams of any length and thickness can be welded by it renders it also valuable in tank making, steel barrel manufacture, and many other industries where hitherto riveting and caulking have been solely employed.

On April 26, the Hon. Judge Chas. B. Whitmer, Judge of the U. S. District Court of the Middle District of Pennsylvania granted an injunction directed to Anthony Walukiewicz, trading as the Wizard Cylinder & Repair Co., of Wilkes-Barre, Pa., restraining them from repairing scored cylinders, thereby sustaining patents owned by L. Lawrence & Co.

BROTHERHOOD OF WELDERS

Welders of America, Gas & Electric, wake up and take notice as your brothers have done in twenty different states. Chicago Local Lodge No. 301, Brotherhood of Gas & Electric Welders & Operators of America announced in the July Engineer that until further notice they would welcome members from any state in the Union, and for the particular benefit of all welders who read *The Welding Engineer*, and for those who get the Engineer and neglect reading it, we again call your attention to the fact that our live wire Local No. 301 now has new members from over twenty different States and to the A. F. of L. Boys we greet you in particular for your kind and earnest co-operation as expressed in your letters of communication. Checks and money orders are coming to us in nearly every mail, keep up the good work boys, and Chicago Local will have five hundred members by January 1st, 1921. Our objects are not only to increase the wage of the good welder who has earned and deserves it, but also to increase the knowledge of the poor welder that be may become a Class A welder—instead of B. C. D. etc., and take his place among those of this highly skilled art and profession. Wake up, boys, get the habit of not only taking *The Welding Engineer,* but read it each month and you will be kept posted on the progress of The Brotherhood of Gas & Electric Welders of U. S. A.

Sincerely and fraternally,

CHAS. H. KNIGHT,
Recording-Secretary,
521 W. Jackson Blvd., Chicago.

The Export Department of the Oxweld Acetylene Company, which was formerly located at the company's factory in Newark, N. J., has been removed to the Carbide and Carbon Building, 30 East 42nd St., New York. The Department has been reorganized and is now under the direction of R. G. Noble, who will coöperate with the general sales department of the Company.

Oxweld equipment is being exported extensively to Cuba and practically every South American country, as well as to Australia, Central America, Hawaiian Islands, South Africa, China, Japan and even Russia. In many of the large mine, shipbuilding and railroad shops in these countries, Oxweld apparatus is standard equipment. In Cuba, a large number of the sugar mills have installed complete welding and cutting departments, revolutionizing the repair and upkeep of the heavy machinery used in this work.

Requirements for greater warehouse space and more central sales office location has been most advantageously effected by the removal of the sales organization of the Davis-Bournonville Co. in Chicago to offices in the Tribune Building, southeast corner of Dearborn and Madison Streets (11th floor) and occupancy of extensive floor space in North Pier Terminal (Section N), 549-559 E. Illinois Street.

Mr. M. S. Plumley, who has been Chief Engineer at the Company's general offices and factories, has been appointed district Manager at Chicago. Mr. Plumley has been associated with the development and application of oxy-acetylene and oxy-hydrogen welding and cutting since its introduction to the metal working trades of the United States.

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HOW TO IMPROVE WELDING AND CUTTING MACHINE OPERATIONS
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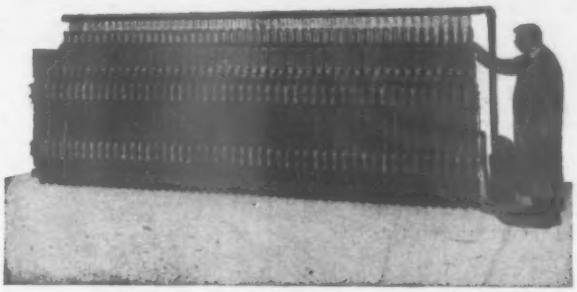

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BOOKS ON WELDING

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If it's in print we have it.

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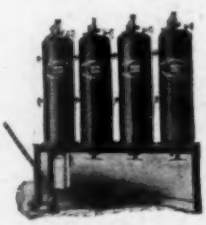

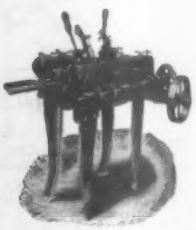

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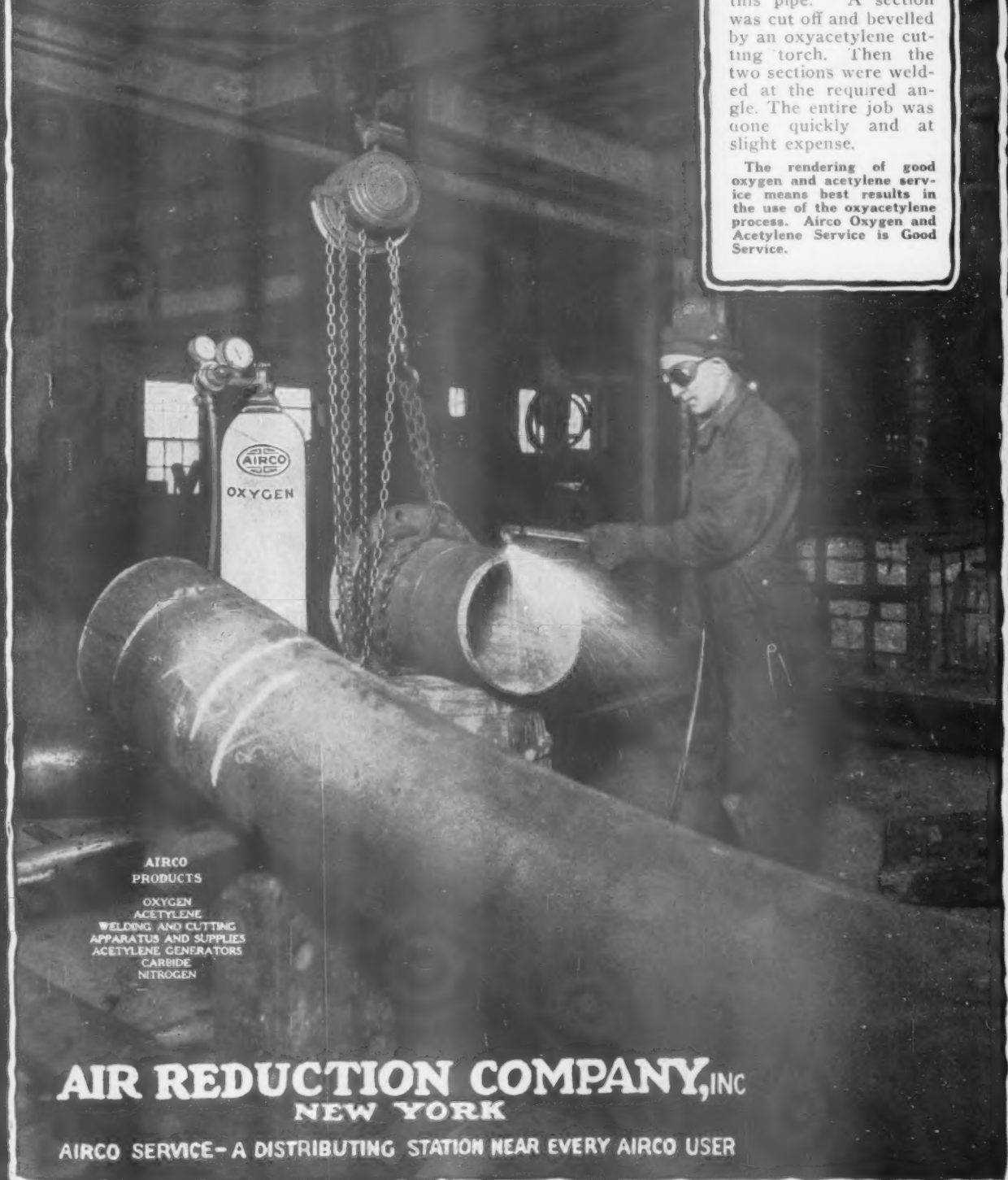
The rendering of good oxygen and acetylene service means best results in the use of the oxyacetylene process. Airco Oxygen and Acetylene Service is Good Service.



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